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ADULT EDUCATION IN GREAT BRITAIN

SPEAKING in the House of Commons on April 23, Miss Horsbrugh, Minister of Education, announced that the grants for adult education next year would be the same as for this year. Thus has ended a period of uncertainty and vigorous discussion which followed the proposal early this year for a reduction of government support of this aspect of the national educational system. Miss Horsbrugh stated that, after consideration of information provided by bodies responsible for adult education in Great Britain, she had concluded that the arrangements by which government support was afforded required reviewing in the light of post-war developments. She proposes, therefore, to set up a small committee to advise her on administrative and financial aspects; until the committee reports, the grants are to be maintained, and even additional assistance may be made available.

The Prime Minister's letter of March 13 to the Trades Union Congress had already stated that no actual decision to cut grants had been made. There was, he added, perhaps no branch of the educational system of Great Britain which should more attract, within its particular sphere, the aid and encouragement of the State than adult education. "How many must there be in Britain, after the disturbance of two destructive wars, who thirst in later life to learn about the humanities, the history of their country, the philosophies of the human race, and the arts and letters which sustain and are borne forward by the ever-conquering English language? This ranks in my opinion far above science and technical instruction, which are well sustained and not without their rewards in our present system. The mental and moral outlook of free men studying the past with free minds in order to discern the future demands the highest measures which our hard-pressed finances can sustain."

The Prime Minister's words recall those of Prof. S. E. Raybould, the first occupant of the new chair of adult education in the University of Leeds, in the survey of university extra-mural education in Great Britain which he contributed to a volume, "Universities in Adult Education", recently issued by the United Nations Educational, Scientific and Cultural Organization*. Most valuable of the results of such education, Prof. Raybould thinks, is "the development of habits of systematic study, of critical thinking, of disciplined discussion; and the result has been the more widespread diffusion throughout the population of the qualities of tolerance, judgment and responsibility which are necessary for democratic life". Nevertheless, to recognize the necessity and importance of adult education is, however, as the Prime Minister concluded, no reason for not looking through the accounts and making sure that all that we can give is turned to real advantage.

The Prime Minister's letter shows clearly that the Government is concerned, and rightly, to ensure that

* Universities in Adult Education. (Problems in Education, 4.) Pp. 172. (Paris: Unesco; London: H.M. Stationery Office, 1952.) 8s. 6d. net.

there are no instances of our limited funds being spent without proportionate result, even on a vital service, where this could be corrected by careful investigation. It is concerned also to examine the prospect of increasing the income for adult education from sources other than, or in addition to, the Exchequer grant. The possibility of an increase in students' fees at least warrants careful attention, and so too does the list of subjects for which public grants are payable.

The agitation will have done good if it stimulates in Britain a more searching public discussion of these matters. Something much more vital, however, is involved than the amount of public grants for such purposes under the conditions of to-day. The fundamental issue is the appropriateness of the whole system of adult education in present conditions. The raising of the school-leaving age and the extension of public grants for scholarships and awards have doubled the number of university students, and the majority of the latter now receive grants from public funds in some way or another. This has transformed the social structure as well as placed severe strains on the universities, and the questions can fairly be asked: Are the methods by which adult education has been conducted in the past really adapted to the new conditions? What should be the function of the Workers' Educational Association to-day? How far is the extra-mural work of the universities in this field consistent with and not inimical to their other duties and the maintenance of academic standards?

Like recent discussions on higher technological education and on the universities and industry, consideration of the place of the universities in adult education brings us to the question of the purpose and function of a university. Without a clear conception of the nature of a university and of its purpose and function in the society of which it forms a part, the allocating of its resources to the best advantage, the scope of its studies, the balance of research and teaching, and of staff and students cannot wisely be determined. How serious such problems have become may be judged from Sir John Stopford's remarks at a recent dinner of the Yorkshire Association of Graduates of Manchester University.

One of the biggest problems of British universities to-day, said Sir John, is the danger that public work may deflect university dons from their prime duty of teaching and research, and there is a possibility that this may get out of hand. He said that at Manchester there are always four or five members of the staff away on the Continent advising foreign governments, and others are helping the British Council or government departments in Britain. The outside responsibilities of the universities have increased enormously since the War, and Sir John referred in particular to the claims made by the National Health Service on the medical staff of the universities. The heavy responsibility of big research enterprises is a further factor. Many such proposals should be rejected by the universities, in Sir John's opinion, because the schemes are too big for the limited resources of a university and would be better undertaken by industry or a research institute.

Such proposals, like projects for sponsored research, must clearly be considered in relation to Great Britain's organization and resources for scientific and industrial research in general, and not purely against the existing resources and commitments of the universities. Above all, however, they should be considered against some clear view of the nature and purpose of a university such as Dr. A. L. Goodhart sought to formulate in his Haldane Memorial Lecture last May (cf. *Nature*, **169**, 986; 1952). Only when we are clear in our minds as to the precise functions of a university and what it should impart to its graduates can we proceed to decide exactly what should be the nature of its teaching or the duties of its staff. Dr. Goodhart laid all the weight of his emphasis on the teaching function of the university: that to his mind is and always will be the primary function. Research of great importance will always be proceeding in any university worthy of its name; but research is not, in his view, the essential purpose of the university. Dr. Goodhart, agreeing with Newman, then urged that it is not what a man has learned but how he has learned it that matters; and he claimed that the habit of mind the university should seek to impart does not depend on the particular subject which the student is studying. The basic mental training of the science scholar and the arts scholar is the same, and failure to recognize this means failure to understand the true purpose of a university, and what it can give to its students. Elaborating this further, Dr. Goodhart stated that clarity of thought and intellectual curiosity are the two transcendent qualities which a university should impart to its members. The first is of supreme importance in national life to-day, and the second, with its emphasis on inquiry, marks the essential difference between a university and a purely technical school.

Dr. Goodhart pleaded that in determining how many students it should admit and what subjects it should teach, a university should above all be mindful of the importance of maintaining its standards, and of ensuring that it fosters the adventurous inquiring mind which has been trained to be accurate; this is in line with Lord Haldane's own ideal of a university. It is encouraging to find that such ideas were reflected in many of the addresses and discussions at the Conference on Industry and the Universities at Ashorne Hill last October, particularly in connexion with the qualities which industry seeks in the university graduate. Their force was equally admitted by Prof. R. S. Edwards in a plea for administrative studies in the universities (*Three Banks Review*, September 1952)—a plea which, however, found little support at that Conference. Prof. Edwards's purpose, however, was at least in part to indicate what is already being done by the universities in this field, and particularly the opportunities for research in the fields lying between the natural and social sciences. The value of such research was stressed at an earlier conference of the Federation of British Industries, when a plea for closer co-operation between industry and the universities in the study of industrial organization and management was advanced by Dr. F. A. Wells.

In this whole context it is appropriate that, as was urged by Prof. Raybould in his book "The English Universities and Adult Education" in 1951, the universities should reconsider their place in extra-mural work, and the nature and extent of their contribution to adult education. Simultaneously, but independently of the Government's suggestions concerning the financial and administrative aspects of adult education as a whole, the value and utility of the Workers' Educational Association—the other means through which Government grants to education have been given in the past—has been challenged by critics, who point to the public library as a more appropriate instrument for public support of adult education. The character of the Workers' Educational Association has indeed changed. By 1932, the proportion of manual workers had dropped to a third and is now not more than 18 per cent. In 1951 the three-year tutorial classes which form the hard core of academic studies were only 14 per cent of all classes, with 12·5 per cent of all students.

Prof. R. H. Tawney's call in 1950 for a return to the first principles of strong working-class membership and exacting educational standards has to be considered in the light of the great social changes of the past fifty years, and especially in public education. To concentrate on working-class students who are capable of sustained study at the university-level means acquiescence in a drastic contraction of the work and influence of the Workers' Educational Association, whereas, in fact, its activities have expanded. Since 1930 the number of students attending its classes has nearly doubled, and the question which has to be asked is whether the Association is the appropriate 'responsible body' for all these activities. Inquiry might indicate that some of them should be entrusted to the university extra-mural departments which are already working on parallel lines, while others might be made more nearly self-supporting or entrusted to local education authorities, which now have responsibilities for further education.

What is clearly required is fresh thinking about the whole problem of further education, and the responsibilities and effectiveness of the several agencies working in that field, in the light of the new social situation and its current trends.

ZOOGEOGRAPHY

Ecological Animal Geography

By Prof. W. C. Allee and Karl P. Schmidt. Second edition. An authorized edition, rewritten and revised, based on "Tiergeographie auf ökologischer Grundlage" by the late Richard Hesse. Pp. xiii+715. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 76*s*. net.

WHEN the originator of this large compilation, Richard Hesse, wrote his German book in 1924, the science of animal ecology was in its early development. That of zoogeography, though with a long history behind it, was confused by the cross-currents of unbridled speculation, now happily beginning to be brought into more orderly notions by the aid of palæontological evidence. In 1924, also, zoologists were beginning to turn towards physiological facts for explanations of the limitations of the range of species and geographical differences of external form. It was natural and useful that the emphasis of Hesse's book should be given to a description of the geographical and physical zones of the world, the more obvious adaptations of animal life to existence in them, and to the relating of animal form and function to physical gradients. Ideas of population—and indeed of time changes at all—were mainly excluded. The American authors who have largely rewritten this book for the second time (the first version appeared in 1937) have not deviated very much from this general outlook, except to mention rather more modern work both on ecology and zoogeography. The book is still a static picture of the world and its animal life—it presents a series of huge 'life groups' from different parts of the sea, land and fresh water; and historical and dynamic processes are almost completely excluded from the story. It is a series of pictures, not the foundations of a special science, for any development from this kind of ecological animal geography would have to study physiological or genetical process, population balance or zoogeographical history. For this reason the book is fairly dull to read, an effect increased by the authors' passion for stating every bit of information in the same tone of voice. There is a curious mingling of absolute platitudes like "Sufficiency of water is most completely assured to animals that live in it" with tongue-twisters for the student like "the camel is a stenohygric animal of arid country", which may at first reading conceal the fact that a tremendous amount of careful scholarship and distillation of written knowledge has gone into making the treatise; and since much zoological information is still rather a chaos of small bits about species or taxonomic groups, except in so far as it has been brought into the field of evolution theory, one must welcome such a solid attempt to describe the faunal features of the world as a whole.

The book falls into four sections. The first is general and, as usual in the Chicago school of zoology, starts with the physical and geographical environment and ends with animal communities (biocœnoses). An indication of the verbal atmosphere in these first 165 pages is illustrated by the following sentence: "The biochores and superbiochores are finally combined into still higher groupings, which may be called 'biocycles' ". Some readers might feel that they needed a 'biocycle' to enable them to get around the 'chores' of reading this sort of superbly unnecessary jargon. Phrases like the "spruce-moose biome" are likely to amuse, without illuminating.

The two succeeding sections, on marine and fresh-water animal life respectively, are much the best parts of the treatise. They are clearly the result of a great deal of search for good information, and, although the separate subjects have to be dealt with in a condensed form, there is no doubt of their real value both to students and to zoologists generally who cannot find time to keep abreast with the wide-ranging research that is going on in our oceans and lakes. It is when we reach the last section, on the distribution of terrestrial animals, that compression defeats its aim. One cannot be satisfied with the eleven lines that are devoted to the coniferous forests of the Holarctic region, or the two and a half pages about the deciduous forests. Modern ecological surveys of the Arctic land regions are not mentioned.

It will be seen that this book is a serious and great effort of scholarly compilation, covering such a huge field that its omissions are not entirely unexpected. It falls somewhere between an encyclopædia and a text-book; but it will prove a valuable work of reference for facts, so long as it is realized that the facts are bound to be very incomplete, that the abundance of rolling jargon does not conceal a dynamic philosophy about animal life, and that the future of zoology lies in the study of processes rather than of panoramas.

CHARLES ELTON

JAPANESE OPISTHOBRANCHS

Opisthobranchia of Sagami Bay

Collected by H.M. the Emperor of Japan. Described, with an Introduction, by Dr. Kikutaro Baba. Edited by Dr. Hirotaro Hattori. Pp. 194+50 plates. (Tokyo: Iwanami Shoten, 1949.) £7.

THERE is now ample evidence of the existence of an opisthobranchiate fauna of great variety and wealth in the seas around Japan—a fauna made the more interesting by its admixture of temperate and tropical forms. The first hint of this was given as long ago as 1880–81, when Rudolph Bergh[1] published his "Beitrāge zur Kenntniss der japanischen Nudibranchien", which, although containing descriptions of only fifteen species, showed that a considerable range of types existed. Bergh's publication, based on collections made by a number of naturalists, was the first attempt at a comprehensive account of the Japanese species. This pioneer work was followed in later years by accounts of further collections, notable among which is Sir Charles Eliot's[2] "Japanese Nudibranchs", published in 1913. This latter is a report on the nudibranchs then in the collection of the College of Science in the Imperial University of Tokyo and describes no fewer than forty-three species belonging to several groups. Coming to more recent times, no one has done more to add to our knowledge of the Japanese representatives of this group of the Mollusca than Dr. Kikutaro Baba, whose long series of investigations, beginning in the early 1930's, are happily still in progress. His contribution to the work recently compiled by the Japanese Imperial Household has been a major one.

It is well known to men of science in general that H.M. the Emperor of Japan is keenly interested in marine biology, and, as is recounted in the preface to this volume, he has long made it a rule, every time he goes to stay at his villa at Hayama, on the eastern shore of Sagami Bay, to organize and take part in shore collecting expeditions. Detailed surveys of many parts of the shore of the bay itself and of the many off-shore islands have been made, and frequently he has gone to sea to collect by dredging, trawling and other means off the coasts of Enoshima and Jogashima Islands in water three hundred or more metres deep.

Sagami Bay is situated roughly in the centre of Japan proper, on the south-east coast of Honshu, and, clearly, many factors combine to make it a rich collecting ground. Bounded on the east by the Miura Peninsula and on the west by the Izu Peninsula, the bay has a wide opening to the ocean. South from its mouth there extends the long chain of the Izu Shichto Islands. The shore is good for inter-tidal collecting; off-shore rocks and reefs abound, forming rich habitats, and beyond them there is water of varying depths dropping to a thousand metres or more in the central part of the bay. Also, at certain seasons of the year, a branch stream of the warm Japan Current (*Kuro-shiwo*), flowing eastwards between Oshima Island and the southern tip of the Izu Peninsula, enters the bay, bringing with it a rich flora and fauna including many species characteristic of more southern waters.

The series of investigations, part of which forms the basis of this book, have covered a period of somewhat more than twenty years and have resulted in the amassing of a large number of specimens of marine algæ and animals belonging to various phyla now suitably preserved for future research. Whilst providing a comprehensive account of the opisthobranchiate Mollusca of this region, it is to be borne in mind that the work is concerned solely with those species taken by the Emperor himself at various stations in Sagami Bay. It is the first volume to be published by His Majesty's Biological Laboratory and, so we are told, will be followed in due course by others on different groups. The species recorded in it are described by Dr. Baba, who has also written the brief introduction. The coloured figures, all of which have been painted from living specimens, and of which there are no fewer than 170, have been executed by the late Hiroo Sanada and Shiro Kato, and the whole work has been edited by Dr. Hirotaro Hattori, chief of the Biological Laboratory of the Imperial Household.

Although partly translated into English, most of the book is written in Japanese, the difficulty of obtaining an adequate translation of which has occasioned the somewhat long delay in the appearance of this notice. That the section in English, which follows the initial Japanese part, is approximately half as long (64, as against 114 pages in Japanese) is not due solely to typographical differences between the two languages, but largely to the fact that a number of interesting and important chapters in Japanese have not been translated into English. Although this has been done, one must suppose, in order to keep the book to a reasonable size, it is much to be regretted, for the topics dealt with in them range from an historical review of work on Japanese forms, an account of geographical distribution, and a brief review of different modes of classification to the phylogeny and relationships of the Opisthobranchiata—matters of great interest to the malacologist in particular and to the zoologist in general.

The longest section in both the Japanese and English parts is the chapter on classification, which contains brief, though evidently accurate and adequate descriptions, accompanied by line figures, of the species which have been collected. One hundred and forty-three species are recorded, fifty of which are new, and five new genera have been established. A world-wide acquaintance with opisthobranchs would be necessary before pronouncing judgment on the validity of the new species described; but it is encouraging to note that in the majority of them the descriptions have been based on series of specimens often collected at different times and from different localities. The description of each species is followed by the briefest of field notes giving the dates and localities of collection and details of distribution.

Coloured figures are an essential accompaniment to any taxonomic work on opisthobranchs, and the fifty plates which form the last section of the book

are attractively produced, sometimes strikingly beautiful, and, so far as can be judged, true to life.

There is no doubt that this work is a valuable contribution to marine zoology and in particular to our knowledge of the Opisthobranchiata of Far Eastern seas; but let us hope that the Emperor and his team of investigators will see fit to follow it up with further publications dealing with some other aspects of the biology of this interesting group of the Mollusca. With such admirable facilities for study in what must be the finest of collecting grounds, it is not too much to expect that observations on general biology, spawning habits and larval and post-larval development, to mention only a few of the topics on which detailed information is so sadly lacking, will be undertaken.

The book is expensive in British money; but it is well printed and in all respects most attractively produced. It is stoutly bound in pale green with gold lettering—in English on the cover and Japanese on the spine. To the British reader, who can scarcely be expected to boast familiarity with all the localities mentioned, the inclusion of a large-scale map of Sagami Bay and neighbourhood would have been an asset.

J. E. FORREST

[1] Bergh, R., *Verh. k.k. zool.-bot. Gesell., Wien*, **30**, 31 (1880–81).
[2] Eliot, C., *J. Coll. Sci. Imp. Univ. Tōkyō*, **35**, Art. 1 (1913).

TEXT-BOOK OF LIGHT FOR DEGREE STUDENTS

Light

(Student's Physics Series, Vol. 1.) By Prof. R. W. Ditchburn. Pp. xxii+680. (London: Blackie and Son, Ltd., 1952.) 45*s*.

THIS book is a most welcome addition to the series which contains, for example, J. K. Roberts's "Heat and Thermodynamics". Despite the multiplicity of books on the subject of light, there are few which are suitable for honours students, and still fewer which approach the degree of completeness and attention to detail shown by this volume. Prof. R. W. Ditchburn is to be congratulated on the production of a work which is a testimony both to his extensive knowledge of the subject and to his powers as a teacher.

The book covers all that is required in physical optics for a degree course, starting from Intermediate level; it does not include geometrical optics, as the title might imply. Problems, on which the student can test his powers, are interspersed throughout the book, and often brief guides to the methods of solution are given.

Having made clear my unqualified opinion of the book as a whole, I should like to direct attention to two aspects in which I feel that the author does not live up to the high standard which he has set for himself. First, he claims, in the preface, that the wave theory has been described in such a way that the quantum theory appears as a natural development. One looks forward to some interesting new approach to the teaching of this rather awkward episode in the history of science, but it is not there; one meets the usual presentation of the quantum theory as a device for explaining, for example, odd effects such as photoelectricity.

Secondly, it is possible that more could be made of Abbe's theory of image formation. I agree that the treatment is at least as full as in any other text-book of light; but, in a book in which so much attention is paid to practical details, it is a pity that the author has not taken the opportunity to reproduce some practical illustrations, which would make the theory so much more real to the student. The concept of resolving power is of such importance in physics that it is unsatisfactory merely to refer students to the original work, which is often not readily accessible to them.

The difficulty is aggravated by the fact that the only practical illustration related to resolving power (Fig. *l*, Plate III) is given a misleading legend; it is actually the Fraunhofer diffraction pattern of a single circular aperture obtained from two point sources near the limit of resolution, but it is described as the "pattern due to two circular apertures which are just resolved".

These are the only aspects of the book which I feel to be unsatisfactory. There are some very minor errors, such as the omission of two minima in Fig. 6.3, and the mention of "the molecule" of mica; but, on the whole, the reading of the book can engender nothing but admiration that one man can cover so adequately the different aspects of physical optics.

H. LIPSON

LEAF-MINING INSECTS

Biology of the Leaf Miners

By Prof. E. Martin Hering. Pp. iv+420. ('s-Gravenhage: Dr. W. Junk, 1951.) 36 guilders.

PRIMARILY, this book is an investigation into the feeding patterns of leaf-mining insects and is the result of years of research by Prof. E. M. Hering on the leaf-mining habit. It is an attempt, based on the nature of the damage inflicted on the plant, which is in itself dependent upon the specific behaviour of the individual species, to identify, often down to species level, a diverse collection of insects.

The first chapter includes the definition and classification of the miners; each type of mine, which is well illustrated, is given a specific name depending upon its shape and form and the part of the plant where it is to be found. The following chapter deals with fundamental morphological characters which separate the four orders of insects—namely, the Lepidoptera, Coleoptera, Diptera and Hymenoptera—to which the leaf-mining habit is restricted. It also discusses the modifications in structure of the larvæ induced by the mining habit and emphasizes the disparities existing between mines caused by members of the different orders.

The author then considers the general life-history of mining insects, with much space devoted to the pupal stage, which tends to show greater variance between species, particularly concerning the selection of pupation sites. There is a tendency for leaf-mining insects to complete their life-history in a shorter time than that required by other phytophagous insects. Reasons for this, such as the consumption of highly nutritious food material and the uniformity of the micro-habitat, are dealt with in a separate chapter.

The extent of Prof. Hering's studies is indicated by the next chapter on disposal of frass, where he utilizes the types of frass deposition as a means of identification. In addition, the problem associated with the disposal of frass to prevent contamination of the mines is discussed.

The special adaptations of case-bearing miners and aquatic plant miners are considered individually. This is followed by a detailed account correlating mining habits with larval morphology, where the influence of environment on the development of the species is fully appreciated.

Associated with a chapter on host selection is a comprehensive list of plant families known to support a leaf-mining fauna. Opposite each family will be found the orders of insects recorded on them. The last part of the book covers the colour of the mines; the effect of mining on the growth of the plant; parasites, inquilines and symbionts; and, finally, a section on collecting, breeding and the difficulties in determination of the more difficult species.

This book contains a wealth of knowledge, the result of more than thirty years detailed study of the subject. It is well indexed, and the bibliography comprises nearly one hundred pages. The work makes interesting reading, the only marring feature being the unusual number of errata.

V. W. Fowler

A PIONEER OF PLANT PATHOLOGY

Erwin Frink Smith

A Story of North American Plant Pathology. By Andrew Denny Rodgers, III. (Memoirs of the American Philosophical Society, Vol. 31.) Pp. x+675+4 plates. (Philadelphia: American Philosophical Society, 1952.) 5 dollars.

ERWIN FRINK SMITH (born in 1854), and from 1886 until his death in 1927 a scientist in the service of the United States Department of Agriculture, was not only the acknowledged 'dean of American plant pathology', but also a man of international reputation, whose pioneer work will always be remembered. In this considerable volume the author has produced an unusually well-documented biography of a great man. The story is simply told and the reader, almost unawares, finds himself living in that great period of botanical renaissance in Europe and of botanical exploration and discovery in the vast regions of the United States. On this period, Mr. A. D. Rodgers is particularly qualified to write. His first pictures of Erwin Smith are of a modest young man of unusual perceptiveness and competence, gradually finding his feet in science and in a philosophy of life, and enjoying in its manifold aspects the poetry of existence in a great and varied continent. Smith's inherent qualities were soon to become evident in an insatiable curiosity about the objects of Nature in general, and plants in particular, in a devotion to the precision of scientific methods, and an eye alert for innovations in ideas and techniques that would open up new high-roads in biology. Thus, a time came when his researches into fungal pathogens, and more especially into the quite new field of the bacterial diseases of plants, were to lead the world. These studies, which were characterized by great thoroughness and a mastery of illustration, have long occupied a fundamental place in this branch of biological science, and will continue to do so. He also made important contributions to our knowledge of plant viruses.

Although this book tells the life-story of a man, it also records the history of an unusually important period in biological and medical science, and in agricultural economy, both in the Old and New Worlds. Accordingly, this volume should prove of value as a source-book for information about the progress of pathology in general, as well as of Smith's own significant and numerous contributions. In this connexion it is probably a pity that in so extensive a book space was not found for a chronological list of Smith's papers and books. The book can also be recommended to all who like to read of lives well lived, and who wish to gain some insight into the springs of contemporary knowledge.

OLD HAWAII

Hawaiian Antiquities (Moolelo Hawaii)

By David Malo. Translated from the Hawaiian by Dr. Nathaniel B. Emerson, 1898. (Bernice P. Bishop Museum, Special Publication 2.) Second edition. Pp. xxii+278. (Honolulu: Bernice P. Bishop Museum, 1951.) n.p.

DAVID MALO was a Hawaiian of good family, born about 1793, who spent his early life at court and became a great authority on native customs and traditions. When he came in contact with Christian civilization, he soon became an enthusiastic convert, and finally a Christian minister. He died in 1853.

His book "Hawaiian Antiquities" was written in the Hawaiian language, and the translation, with notes, by Dr. N. B. Emerson, edited by W. D. Alexander, was published by the Bishop Museum as long ago as 1903. It has long been out of print, and this second edition, which is little altered apart from improvements in format, has been issued in response to many requests.

The title of the book is misleading, since it is not an archæological treatise but rather an account of Hawaiian ethnology before contact with European civilization. It deals with many things, including customs, ceremonies, myths, traditions, the code of conduct, political organization, sports and material culture. Under the last-named heading are accounts of such matters as house building, furniture, food, bark cloth, stone adzes, canoes and articles of value, which will be particularly useful to those who have Hawaiian collections under their care. The few drawings which accompany these sections are probably Emerson's. Wherever appropriate, the native names of objects, ceremonies, etc., have been quoted in the translation, which therefore constitutes a kind of glossary of Hawaiian terms.

As a convert to Christianity and an admirer of Western civilization, Malo was bound to regard the old ways with disapproval, which comes out in such statements as "The newly imported articles are certainly superior to those of ancient times" and "Some of these miserable practices of the ancient Hawaiians were no doubt due to their devotion to worthless things"; but remarks of this kind are confined to a few lines at the ends of chapters, and most of the work seems purely objective. If he had known to what extent future generations would have to depend on writings such as this for information about his forbears, he would doubtless have dealt with many matters more fully than he did; nevertheless, we can learn a great deal from the book, and in the circumstances it is greatly to his credit.

G. H. S. Bushnell

The Aphid Genus *Periphyllus*

A Systematic, Biological and Ecological Study. By Prof. E. O. Essig and Frieda Abernathy. Pp. ix+166. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1952.) 22*s*. 6*d*. net.

IN a family of insects remarkable for the variety of forms which may be assumed by a species during the course of a single life-cycle, the aphid genus *Periphyllus* van der Hoeven is peculiar in that most of its members produce, in addition, specialized æstivating larvæ which remain in the first instar from the spring until the autumn, when growth and development are resumed. The members of this genus are nearly all confined to trees of the maple family, on which they complete their life-cycles.

This book embodies the results of six years of study of a number of American species of *Periphyllus*, and includes descriptions of others from Europe and eastern Asia. In their accounts of species which they have been able to study at first hand, the authors have contributed materially to our knowledge of this group, and, with the aid of copious illustrations, have shown the remarkable degree of variation in form which can occur during the life-cycle of a single species. The inclusion of lists of synonyms, host plants, notes on history and distribution, together with an impressive bibliography, usefully brings together a quantity of relevant material within the compass of a single volume. But in their survey of the genus as a whole, it is disappointing that the authors appear to have overlooked some important contributions from European workers. There is no mention of the recent work of Börner, nor of Hille Ris Lambers's very full and detailed account of the known European species of *Periphyllus* (*Tijdschr. Ent.*, **88**, 225; 1947).

In an otherwise attractively produced book, it is difficult to understand why most of the numerous line-drawings have been reproduced in half-tone, a process which, besides obscuring important anatomical details, does much less than justice to Frieda Abernathy's fine draughtsmanship. J. P. DONCASTER

Amino Acids and Proteins

Theory, Methods, Application. Compiled and edited by Prof. David M. Greenberg. Pp. ix+950. (Springfield, Ill.: Charles C. Thomas; Oxford: Blackwell Scientific Publications, Ltd., 1951.) 110*s*. net.

THIS is an omnibus volume intended "to acquaint students and investigators with the more general methods employed in the study of the proteins, and to give a summary of the current knowledge and advances of the subject matter". Its aim is therefore nothing less than a comprehensive treatment of amino-acids and proteins from the physico-chemical, organic and biochemical points of view. There is, in fact, no marked emphasis on any particular aspect; there are four chapters on the organic chemistry of amino-acids and peptides, two on the organic chemistry of proteins, three on the physical chemistry, and four on biochemical topics. Most of the major lines of protein research are represented; there is, however, little about the determination of the sequence of amino-acids in proteins, and nothing about specific chain-configurations.

In a book of such scope, with a multiplicity of authors, it is almost inevitable that the treatment should be uneven and perhaps inadequate in parts. The accounts of paper chromatography and peptide synthesis are, for example, well below the average standard of the work. A rather more serious criticism is that the text is not always as up to date as one would wish. In my opinion the book does, however, succeed in bringing to the reader, in the form of a series of separate essays, a large amount of information, some of which is not readily available elsewhere. The numerous tabulations of data are a particularly praiseworthy feature. I have no doubt that students and investigators will find the book useful. It is very well produced, and contains remarkably few misprints. C. H. BAMFORD

Sound

An Advanced Course. By Dr. H. F. Boulind. Pp. vii+104. (London: John Murray, Ltd., 1952.) 6*s*.

IT is difficult to believe that a small book of a hundred pages on sound can cover adequately the required ground for all stages of the sixth form and up to university scholarship-level, no previous knowledge of the subject being assumed. This, however, is what is claimed for this book which, on the whole (and understandably in the circumstances), is rather utilitarian in its approach, with one eye constantly on the examination question.

One has a great deal of sympathy with the author in his admission that his chief aim is to produce a book at a cost within the financial allocation for sixth forms. But surely the correct approach is to supply a really satisfying account of the subject, especially in sound, which has for so long been neglected, and then press the authorities to bring the allocation more in accord with present prices. Sixth-form and scholarship students certainly need, and deserve to have, a full and comprehensive volume for their studies, and it is high time that this serious defect on the part of those responsible was rectified.

What is done in this book is, as is to be expected, done well. The mathematics is well within the scope of the students for whom the book is intended, and there is an excellent set of graded questions. It is a pity that a bigger quantity of information of the same high quality could not be included.

Gods, Graves and Scholars

The Story of Archæology. By C. W. Ceram. Translated from the German by E. B. Garside. Pp. xii+433+32 plates. (London: Victor Gollancz, Ltd., in association with Sidgwick and Jackson, Ltd., 1952.) 21*s*. net.

THIS book is not intended for the specialist in prehistoric archæology; it is rather meant to fascinate the ordinary intelligent reader and to inspire him to delve more deeply into the subject. The author describes in graphic language the story of the discovery of several different sites in a number of localities; for example, he relates the earliest discovery of, and the first explorations at, such city sites as Pompeii, Troy, Mycenæ and Crete, and the origins of Egyptology. Again, the unearthing of Nineveh is recounted, as well as how the deciphering of Babylonian writings took place. The New World is not forgotten, and there is an exciting chapter on the empires of the Toltecs, the Aztecs and the Mayas. The historical approach to the subject is a good one and will undoubtedly excite many readers to dig more deeply into its problems, and the book can therefore be recommended. But even on the historical side it does not pretend to do more than dip into the subject here and there; it does not cover the ground as does such a work as Daniel's "Hundred Years of Archæology". None the less, it makes good reading. The translation runs smoothly. M. C. BURKITT

BEHAVIOUR OF ENGINEERING STRUCTURES*

By Prof. A. J. S. PIPPARD, M.B.E.
Imperial College of Science and Technology, London

THE intelligent and economical design of engineering structures demands knowledge of their behaviour under load, and it is only in the light of this knowledge that the technical efficiency of a design can be assessed. It is, however, usually considered sufficient merely to estimate the distribution of stresses in a structure under normal load-conditions and to design to a factor of safety; while this will often produce a safe result, reliance upon such a simple method may very likely in special cases be either uneconomical or dangerous. In such cases detailed knowledge of stresses and displacements throughout the whole range of loading is desirable.

For idealized structures in which all the material and every member is assumed to obey Hooke's Law, the analysis of stresses and deformations is usually possible by well-known classical methods; but while over-simplification is tempting, it may well prove inadequate in many real structures, where practical factors complicate behaviour.

In many forms of construction one such factor is flexibility, which causes certain members to bow and even become unstable under load; the structure then behaves differently from the manner which would be forecast on the assumption of a linear load-displacement law. This form of elastic instability may occur, for example, in ship plating, which is thin in relation to its unsupported width, with the result that, while the distribution of tensile stress across the deck under a hogging bending-moment is reasonably uniform, the distribution of compressive stress under a sagging bending-moment is not. At the boundaries, where the deck is stabilized by the side plates, the stress is larger than that calculated by simple bending-theory, but at the centre it may drop to a very small value, in some cases almost to nothing. Instability in compression, by thus modifying the stress distribution deduced from the Bernoulli assumptions, may reduce the load-carrying capacity of the hull considerably.

Experiments carried out in the Civil Engineering Laboratories of the Imperial College of Science and Technology, London, on an idealized model of a hull illustrate this point, and a typical set of results are shown in Fig. 1.

Again, most constructional materials depart from Hooke's Law at stresses considerably below failure. In mild steel the breakdown of the linear relation between stress and strain is followed by yield during which strains increase greatly with no increase in stress. So long as the load on a structure is below that required to produce a stress causing yield in any member, the results obtained by classical mathematical methods will, in many instances, give excellent approximations both to stresses and displacements throughout the structure; but if this loading be exceeded, such calculations may be seriously in error.

For some years attention has been focused in a number of countries upon the problems of design introduced by a consideration of the phenomenon of plastic yield, with the object of basing the design of steel structures upon the ultimate load which they can carry rather than upon their behaviour in the elastic state. In Great Britain the lead in this work has been taken by Prof. J. F. Baker, of the University of Cambridge, and in the United States, where the method is known as 'limit-design', by Prof. W. Prager, of Brown University, and Prof. J. van der Broek, of the University of Michigan. More recently, a somewhat similar method for application to reinforced concrete frames has been developed by Prof. A. L. L. Baker, of the Imperial College of Science and Technology, London.

It may be remarked that there is nothing essentially new in the philosophy underlying these ideas, since for aeroplane frames ultimate strengths have always been adopted for specification purposes, and design based on a load factor has ensured a reasonable margin over normal flight conditions.

In the application of limit design to structures built of mild steel, however, the phenomenon of yield introduces the need for special treatment. When yield starts, the portion first affected can stretch considerably without carrying any more stress, and adjacent portions will have increased stresses thrown upon them. They in turn will yield, and ultimately the whole region will become plastic and form a hinge with a constant moment of resistance which can be calculated solely from the dimensions of the member. If such a hinge develops in a redundant structure and if the load on the structure be further increased, the bending moment at the plastic section will remain constant and further hinges will develop successively at other sections of the structure. When a sufficient number have formed, the structure will be statically determinate, and if loading is still further increased it will become a mechanism and collapse. It is evident that if the positions of all the plastic hinges can be foretold, the load required to cause this failure of the structure can be readily calculated.

It should be noted that with the development of each hinge the structure changes its character, and a simple parallel to this behaviour may be observed in a voussoir arch, a structure formed of a number of wedge-shaped blocks the mortar joints of which

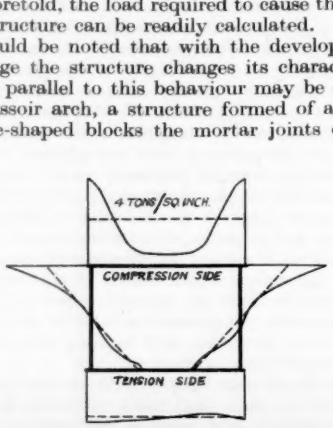

Fig. 1. Typical stress distribution around thin-walled box girders. The broken line shows the Bernoulli distribution

* Based on a series of lectures given at the Royal Institution on February 17, 24 and March 3.

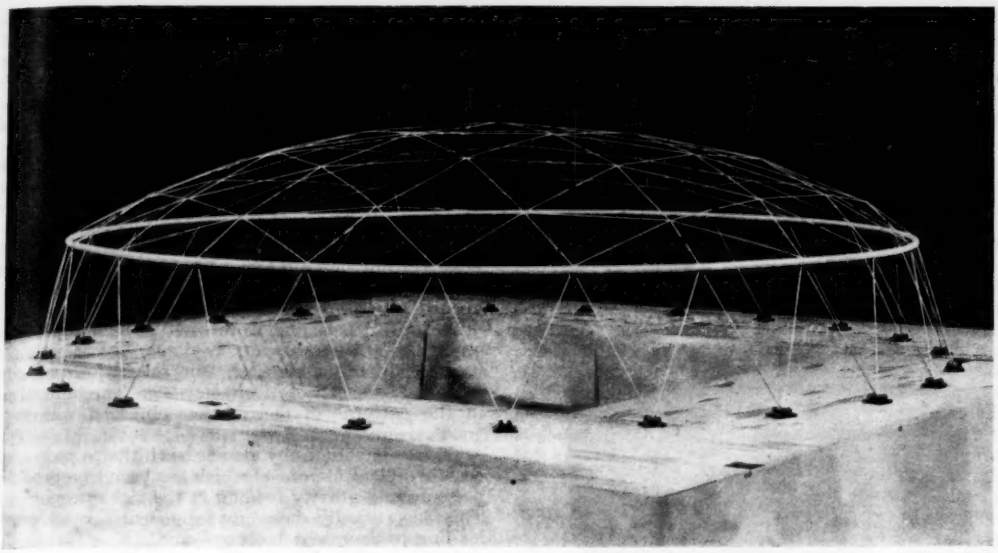

Fig. 2. Elastic model of the Dome of Discovery

are generally assumed to be incapable of resisting tensile stress. Under dead loading the arch behaves as a solid encastré rib, having three degrees of redundancy. If an increasing load be applied to any voussoir, the structure will continue to function as a solid rib up to a certain, calculable, value at which the loaded voussoir and that adjacent to it which is nearer the crown of the arch will make contact only along their edges on the outer boundary or extrados, and a virtual pin-joint will be established. The degree of redundancy is reduced to two, and, with further increases in the load, additional virtual pins will develop successively until the structure is effectively hinged not only near the load point but also at points on the inner boundary or intrados and at, or near, one springing of the arch. The structure is then statically determinate until the load is increased to a value which produces a fourth virtual pin at the other springing. It then becomes a mechanism, and its collapse, as shown in a film record of an experiment carried out on a model structure with steel voussoirs, is practically instantaneous[1]. We are concerned, then, not with a single arch but with four different arches each corresponding with a certain range of load carried. In a steel frame the number of effectively different structures may be much greater since the initial degree of redundancy can be very much higher. It is therefore a matter for discussion as to whether it is more rational to base a design on the particular structure which operates just before the failing load is reached, and which it is never expected even to approach, or upon that which does in fact carry the normal working loads. It is perfectly legitimate to adopt the former basis of design, and it will, in some cases at least, simplify calculations considerably; but the claim sometimes made that it produces economy in material does not appear yet to be established and must in any case depend upon the relative values of the load factor and factor of safety used in applying the two methods.

The logical position would appear to be to recognize that, unless we can calculate the failing load of a structure, there will always be uncertainty as to what working stresses we may justifiably use. The more we know about the behaviour of a structure, both in the elastic and plastic phases, the surer will be our position in the effort to achieve economy. It may be hoped, therefore, that we shall not see the growth of two rival schools of thought, the 'elastics' who see no good in the new approach and the 'plastics' who profess to believe that a new era in engineering has dawned in which the classical methods will find no place. Such a dichotomy might easily result in well-proved methods sinking into disrepute on one side, and first-class research being neglected on the other. There should, in fact, be no fundamental antagonism between the two points of view; each concerns itself with the behaviour of structures under certain defined conditions, but both are necessary for proper understanding. Surely the approach to design should be neither exclusively plastic nor elastic but 'elasto-plastic'.

Our present knowledge of structural theory is the sum of mathematical speculation, during a period of two or three hundred years, of many experiments made in the laboratory, of a comparatively few full-scale tests and lastly, but very important, of observed structural behaviour, especially in accidental failures.

The development of elastic theory has been dealt with at length in many publications, and it is unnecessary, and indeed impossible, to traverse the ground in a short article.

As an example of the lessons to be learnt from accidents, the failure of the Tacoma suspension-bridge may be cited[2]. Soon after its completion, this bridge developed a tendency to oscillate in a wind, and was in consequence subjected to continuous close observation. After it had been in service about five months, a steady 40-m.p.h. wind set up a violent motion which grew steadily worse; longitudinal and torsional oscillations increased in amplitude, and within a short time the whole structure collapsed. Cinematograph records throughout the final stages furnished a complete story of the disaster, and

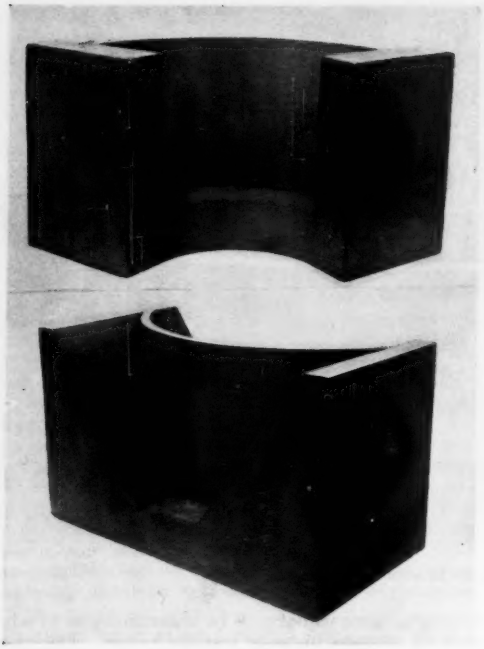

Fig. 3. Models of arched dams in indiarubber

mathematical and experimental study showed it to be due to the aerodynamic phenomenon of flutter which had hitherto been associated only with aeroplane wings and control surfaces. This disaster, although tragic in itself, served to attract attention to vital points in design which up to then were unsuspected as potential sources of danger, and no designer would now consider building a large suspension-bridge without making a very full investigation into its aerodynamic properties. As a case in point, the design for the proposed Severn Bridge has been subjected to exhaustive wind-tunnel tests under the direction of Dr. R. A. Frazer, of the Aerodynamics Division of the National Physical Laboratory, Teddington.

Learning from accidents is, however, expensive and uncertain, and, just as there are ways of roasting pig cheaper than burning down the house, so there are other methods of studying structural behaviour. The development of research into plastic behaviour, partly mathematical and partly experimental, has already been mentioned. A new and powerful analytical weapon has been provided by Sir Richard Southwell, who has devised the relaxation process which enables numerical answers to be obtained for a wide range of problems which are difficult or even intractable by classical methods.

The development of laboratory techniques for the study of structural behaviour is comparatively modern. Some of these are so simple that it is now fairly common, for example, to find experimental stress analysis by celluloid models carried out in the offices of practising engineers either as a sole method or in conjunction with calculation. This, based on Clerk Maxwell's reciprocal theorem, is an indirect method—that is, it requires no direct measurement of stresses; these are inferred from a comparison of measured displacements. A recent extension of the method[3] has been a study by means of an elastic model of the stresses in the Dome of Discovery of the Festival Exhibition, London (shown in Fig. 2). The experimental results were very good compared with those found by a relaxation process and indicate that space as well as plane frames can be reliably analysed in this way.

Photoelastic investigations are proving valuable in plane and three-dimensional stress problems, and considerable use is being made of electric-resistance strain gauges to obtain complete pictures of stress distribution in a variety of structures. One such investigation has already been mentioned, and the curves of Fig. 1 give an idea of the possibilities opened by this post-war technique.

In 1907 Wilson and Gore[4] used rubber models to study the stresses in gravity dams, but it was not until 1947 that Zienkiewicz[5], using relaxation methods, provided exact theoretical solutions. The agreement in the patterns of distribution obtained was very good[6].

The study of dams by models has hitherto presented certain difficulties, one of which has been to reproduce pressure and gravity loading in the right proportion. This has usually been met by using mechanical loading to represent both systems.

Another difficulty has been to obtain material which could be formed to the correct shape, which satisfied Hooke's Law and which was sufficiently flexible to give displacements large enough for accurate measurement. Rubber Technical Developments, Ltd., of Welwyn Garden City, by a newly developed technique, have produced excellent pilot

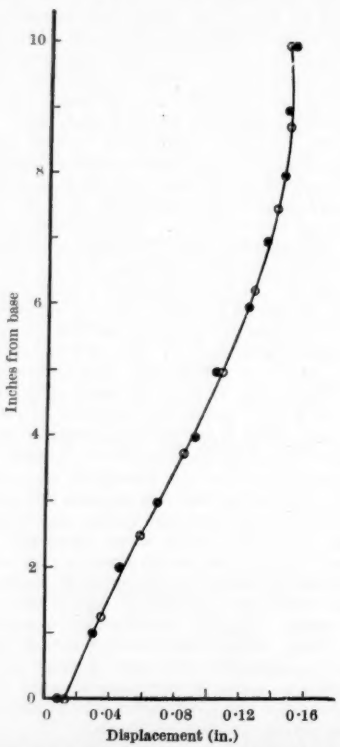

Fig. 4. Upper model of Fig. 3. ⊙—⊙—, calculated (curve drawn in); ●—●—, experimental

models of arched dams in suitable material having a Young's modulus of about 120 lb./sq. in., and these are shown in Fig. 3. Fig. 4 shows the measured deflexions of the centre line of the first model due to water pressure, compared with those calculated by relaxation methods. A much larger model of a projected dam has now been successfully moulded, and an extensive programme of research started in the Civil Engineering Laboratories of the Imperial College.

To determine gravity stresses at any point on the surface of the dam, the strains produced when the model is turned upside down will be measured; these will be twice those due to gravity loading, and the stresses deduced from them, when multiplied by the scale factor and by the ratio of the densities of the prototype and the model, will give the gravity stresses in the real dam. The full-scale stresses deduced from strains in the model due to water pressure alone can then be added.

The objective of the engineer in actual construction, and the crucial test of the value of calculation or research will always be the extent to which it helps to give a true idea of the behaviour of real structures. More full-scale tests for comparison with the results obtained by calculation or experiment are consequently vital if progress in structural engineering is to continue, and arrangements are being made by the Institution of Civil Engineers for a conference on this subject in 1955. Any engineer who is in a position to contribute records of results obtained from actual stress or displacement measurements on real structures, especially if correlated with calculations or tests, is invited to communicate with the Secretary of the Institution so that tests can be co-ordinated to yield the maximum amount of information.

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[2] Steinman and Watson, "Bridges and Their Builders", 353 (New York: G. P. Putnam).
[3] Makowski, Z. S., and Pippard, A. J. S., *Proc. Inst. Civ. Eng.*, Pt. 3, 420 (1952).
[4] Wilson, J. S., and Gore, W., *Min. Proc. Inst. Civ. Eng.*, **172**, Pt. 2, 107 (1907–08).
[5] Zienkiewicz, O. C., *J. Inst. Civ. Eng.*, **27**, 244 (1946–47).
[6] Pippard, A. J. S., *J. Inst. Civ. Eng.*, **33**, 264 (1949–50).

SULPHATES IN AFRICAN INLAND WATERS

By R. S. A. BEAUCHAMP

East African Fisheries Research Organization, Jinja, Uganda

THE larger African lakes receive from their inflows small amounts of water relative to their volume, and these inflows usually contain inconsiderable amounts of sulphate. Data from Lake Tanganyika[1] show how sulphates are being removed from solution. The outflow from this lake is small and at times, when the lake-level is low, no water flows out of the lake. Consequently, one might expect the values for most dissolved salts in this lake to be higher than the mean values for these substances in the inflows. This is in fact so for sodium, potassium, chloride and phosphate, being three or more times the values obtaining in the inflows; but the concentration of sulphates in the lake is less than half the mean concentration contained in the inflows.

In any lake a shortage of sulphates may arise unless adequate amounts are supplied by inflowing streams, as the balance of biological processes acts in such a way that sulphates in solution are utilized and precipitated faster than they are released by the decomposition of organic matter. The main loss of sulphates is brought about by protein synthesis and the subsequent precipitation of this organic matter, both vegetable and animal, on to the bottom. Decomposition of this organic matter usually occurs under anaerobic conditions leading to the formation of hydrogen sulphide and insoluble sulphides. Sulphates may also be reduced directly by bacterial action to sulphides. Once they have been reduced, either directly or indirectly, to metallic sulphides in the mud, and then overlaid by further deposits, little of this sulphur is recovered and put back into circulation. On the other hand, sulphates are returned to the water when organic matter is decomposed aerobically; however, in most lakes there is usually less opportunity for aerobic decomposition than there is for anaerobic decomposition, and not all the organic matter which is decomposed aerobically is broken down completely. Thus, on balance, the biological processes occurring in lakes cause a continuous removal of sulphates from solution. This is a matter of little consequence in lakes which are fed by inflows containing amounts of sulphate sufficient to maintain an adequate supply.

Though Lake Tanganyika has been used for illustrating the contention that sulphates are continually being removed, it does not show how far this process may be carried, probably because biological activity is limited in this lake by marked thermal stratification. The waters of Lake Tanganyika[2] contain about four parts of sulphate per million, but many of the African lakes contain less. In some of these it seems that sulphate deficiency may be a factor affecting the growth of phytoplankton. The following values as parts per million have been recorded:

Lake Rukwa[3]	2·9
Lake Bangweulu[3]	2·3
Lake Albert[4]	< 2·0
Lake Victoria[4–6]	0·8–1·8
Lake Mweru[7]	"traces indosable"
Lake George[4]	< 0·5

The last lake is not infertile or unproductive, it is probably the most fertile lake in East Africa; but clearly there are occasions when the available sulphates are reduced by the phytoplankton to a very low value. Data collected suggest that sulphates may be a factor controlling the level of productivity both in Lake Victoria and in Lake George.

The small amount of sulphate in solution in Lake Victoria appears to be restricting the growth of the phytoplankton, judging by experiments with algal cultures at present in progress. It is hoped that the results of these experiments, which are being carried out in this laboratory, will be ready for publication shortly; they indicate that values for sulphate below 0·5 p.p.m. are too low for algal growth. These results are surprising when one considers that phosphorus, which occurs in algæ in about the same amount as sulphur, is absorbed from water containing concentrations of phosphate so low as one part per hundred million or less. It is, of course, extremely difficult to make a really close assessment of the value at which a particular chemical substance becomes limiting in any particular lake. This is especially so under tropical conditions where in the absence of a marked seasonal cycle the release of nutrients and their

utilization is a more or less continuous process, except in such lakes as Tanganyika, Nyasa, Edward, and parts of Lake Victoria, where periodic thermal stratification leads to interruptions in the growth of the phytoplankton.

Lake George was described as probably the most fertile lake in East Africa: it supports a dense phytoplankton and a very large population of fish; yet sulphates, which are essential for plant growth, are not detectable in solution in the water. This statement invites consideration of the question: What determines productivity in tropical lakes? It may be assumed that light and heat are not limiting factors. It seems that in the shallower tropical lakes, such as Lake George, which have a free circulation between surface and bottom water, the level of production must be determined by the rate at which nutrient salts can be taken up, turned into organic matter, both vegetable and animal, and then decomposed to provide nutrient salts again. If this cycle is completed rapidly, production will be high; if slowly, production over a given period will be low. Our observations indicate that the slower processes in this cycle, and therefore the ones controlling its rate, are those concerned with the decomposition of organic matter, particularly matter of vegetable origin. Thus anything tending to increase the rate of decomposition will accelerate the whole biological cycle and increase productivity. The part played by animals in determining the rate of this cycle is certainly considerable, as animal matter decomposes rapidly, whereas plant matter decomposes slowly. Animals also during their lifetime are continually breaking down organic matter and fertilizing the water with their excreta, both fæcal and urinary[8]. Urinary excretions may be of particular significance with regard to the release of sulphates. Thus up to a point the more herbivorous animals in a tropical lake, whether they be copepods, fish or hippopotami, the faster the biological cycle and the higher its fertility and the greater the density of fish it can support. This theory contrasts strongly with ideas derived from the study of temperate lakes and may have an important bearing on problems concerning the overfishing of tropical lakes, particularly those where the industry is based on herbivorous fish such as *Tilapia*, which feed directly on the phytoplankton. Apart from these considerations regarding the way the fauna may affect the rate of production in a lake, productivity is also determined by the total amount of nutrients in circulation.

Sulphur is essential to living organisms, as all proteins contain this element; but it has not received as much consideration by either hydrobiologists or agriculturists as either nitrogen or phosphorus, as in most parts of the world sulphates occur in considerable quantities in both inland waters and the soil. In many parts of Africa this would seem not to be so. Unpublished records of water analyses made by government chemists and public analysts have been collected from rivers, streams and boreholes in different parts of Africa, including Nigeria, the Belgian Congo, Northern and Southern Rhodesia and Natal, as well as from East Africa. Unfortunately, in many cases no estimates have been made for sulphates, but in a great many cases where they have, the values recorded are low; often they are referred to as nil or negligible. This naturally raises the question whether or not the soils of Africa are short of sulphates; requests for information to the various agricultural departments have yielded little positive information, as estimations for sulphates are not usually included in routine analyses. However, P. R. Hesse, a member of the East African Agriculture and Forestry Research Organization, who is working on the effect of termites on the soil, has determined the sulphate content of a great many soils in Northern and Central Tanganyika, the Eastern Rift Valley in Kenya, also near Kisumu, and at Kawanda and Jinja in Uganda. These analyses were carried out in order to compare the chemical composition of the surrounding soils with that of the termite mounds. His results are not yet published, but in all the areas quoted only traces of soluble sulphates were found.

The red upland soils in the Kongwa area were found to contain no soluble sulphates; these analyses were done by B. Anderson. High values for sulphates were found, however, in the grey mbuga clays in the same area—these will be referred to later.

Certain soils in Nyasaland[9] were found to be deficient in sulphates; this deficiency had a serious effect on the tea crop.

Fertilization experiments carried out by agriculturists with the intention of discovering the value of adding nitrogen to the soil have shown excellent results in many parts of East Africa, but the fertilizer used for this purpose has been ammonium sulphate; it is possible that the sulphate radicle has played a part in giving these good results. In other fertilization experiments using superphosphates, it is possible that in some cases beneficial results have been partly due to the presence of calcium sulphate contained in this fertilizer; superphosphates[10] may contain up to 20 per cent of calcium sulphate.

Many more data are required, but there are indications that at least some African soils are deficient in sulphates; apart from the work done on the Nyasaland tea crop, there appear to be no other records of experimental work specifically designed to show this. It would be interesting to know whether in certain areas the addition of sulphates, such as calcium or sodium sulphate, can increase the growth of crops. One record of such an experiment[11] comes from the Gezira, Sudan, where the application of two tons of gypsum per feddan increased the yield of cotton by more than thirty per cent; but this experiment was carried out with the idea that gypsum would improve the texture of the soil and the results were attributed to this effect, as in this region sulphates do occur in considerable amounts in the subsoil.

Brief reference should be made to those waters in Africa in which sulphates have been found in both moderate and large amounts. The streams on Mount Meru[12], Tanganyika Territory, can be divided into two groups—those originating from the less-weathered rocks and those from the more-weathered rocks; the former have a sulphate content of less than ten parts per million, the latter a sulphate content of between twenty to sixty parts per million. Three streams contain more than one hundred parts per million of sulphates. Mount Meru is composed of igneous rocks and lavas.

The soda lakes of the Eastern Rift Valley form a series in which the sulphate content is high, culminating in Lake Nakuru[13], with a value of two hundred and fifty-three parts per million, and Lake Magadi, which is the extreme example but is usually dry. The sulphates in these lakes may not have been utilized fully and precipitated biologically, because the high soda content has restricted the

growth of both flora and fauna. The drainage basins of these lakes contain alluvial deposits formed by lakes which existed earlier; at the present time these lakes have no outlet, and thus their chemical content is the result of the leaching of the surrounding soil and the concentrating of their inflows over a long period of time. Lakes Naivasha and Baringo[13] contain seventeen and forty parts per million, respectively.

The grey mbuga clays in the Kongwa area, referred to earlier, have high sulphate values. Mbuga is the local name for low-lying depressions in the ground which in the past probably contained lakes. These depressions have accumulated salts leached from the surrounding countryside. Borehole waters in this area contain very large amounts of sulphate, ranging from one hundred parts per million to two thousand parts per million.

Hot springs may contain large amounts of sodium and calcium sulphate; one in Northern Rhodesia[14] contains one thousand and fifty parts per million, another in Uganda[4] contains approximately five thousand parts per million. The Northern Rhodesian spring contains ninety parts per million of calcium, whereas the Uganda spring contains two thousand parts per million of calcium. As this spring flows into the Semliki River, and so into Lake Albert, it and other springs in the neighbourhood may be responsible for the relatively high value for calcium in this lake. At the same time, it is worth noting that, as recorded above, the value for sulphates in Lake Albert have been found to be less than two parts per million, indicating that most of the sulphate that finds its way into the lake is used up.

Some swamps in the Kigezi district[15] of Uganda contain very large quantities of ferrous sulphate; these may receive water from some volcanic source.

Streams contaminated by washings from dumps formed by concerns smelting copper are rich in sulphates. Examples of these from Northern Rhodesia[14] show values for sulphate ranging between four hundred and seven hundred and eighty parts per million, whereas streams near by are recorded as containing no sulphate. The refining process of copper is usually carried out by calcining the copper sulphide ore with lime; the waste product formed is mainly calcium sulphate. This by-product may prove to be a valuable fertilizer for fish farms and possibly for agricultural purposes. In this connexion it is worth recording that the smelters also discharge vast quantities of sulphur dioxide from their chimney-stacks. The safe disposal of this gas presents some problems as it is not in Africa an economic proposition to convert all this sulphur dioxide into sulphuric acid, although this acid is in great demand in other parts of the world. Greater demands for sulphuric acid may soon arise in East Africa, including the need to produce superphosphates from rock phosphate. A by-product of this process is again calcium sulphate.

One generalization may perhaps be permissible in order to explain the apparent shortage of sulphates in Africa. In other parts of the world sulphates are usually derived from sedimentary rocks, mostly ancient marine deposits; such rocks are rarely found in Africa. The fact that the only sources of gypsum in East Africa are those contained in the cretaceous deposits along the coast of Tanganyika Territory may serve to emphasize the point.

More data are required; but the evidence we have at present indicates that many of the natural waters of Africa are short of sulphates, and some of the soils also. The main purpose of publishing this account is to arouse interest in what may be a most important problem, not only to those concerned with inland fisheries but also to those concerned with agriculture and animal husbandry.

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THE FIFTH PAKISTAN SCIENCE CONFERENCE AND THE PAKISTAN ACADEMY OF SCIENCE

By Sir HAROLD HARTLEY, K.C.V.O., C.B.E., F.R.S.

IN February Dr. George Taylor and I, representing the British Association, were the guests of the Pakistan Association for the Advancement of Science for its Fifth Science Conference at Lahore, and for a study tour of Pakistan. The Conference was opened by the Governor of the Punjab, who spoke of the progress that had already been made in the Punjab both in strengthening scientific education and in establishing a number of research laboratories which are attacking urgent problems such as water-logging and the salinity of agricultural land. He spoke of the need of Pakistan, an under-developed country, for scientists and engineers, and the help that international co-operation would bring. The president, Dr. Bashir Ahmad, vice-chancellor of the University of the Punjab, took as the subject of his address "Our Problems of Higher Education and Science". His main theme was the position of science in general education not merely for its material benefits but also for its unique function in guiding sound emotional development. Science, he said, is the systematic knowledge of Nature and her ways. That knowledge has cultural value which is as significant as that of philosophy, fine arts or literature. He made a strong plea that science should be a compulsory subject in the school curriculum. He emphasized the need of Pakistan for institutions of higher learning and science, which must remain free from political control in order to achieve their objectives.

The work of the Conference was done mostly in eight sections covering the main branches of science, engineering, agriculture and medicine. Many papers were read describing recent research work in universities and research laboratories in both Western and Eastern Pakistan. Most of them dealt with applied

science, and they showed what a realistic and successful contribution is being made to national development, particularly in agriculture, genetics, entomology, chemistry and economics.

In addition there were a number of general lectures; for example, by Prof. H. J. Bhabha, director of the Tata Institute of Fundamental Research, on cosmic rays, by Dr. Taylor on south-east Tibet and on the work of the British Museum, and by myself on the art of discovery and on limiting factors in production.

The Conference was extremely successful. Large numbers of young students came to the meetings and were obviously keenly interested in the papers. Both during the meeting and after its close, the twenty-five foreign delegates were able to visit a number of research laboratories, including Dr. Chaudhury's new nuclear physics institute at the Government College, Lahore, which will be finished shortly, and the Punjab Agricultural College and Research Institute at Lyallpur, where a large programme of research is in full swing. It covers the main agricultural problems of Western Pakistan and much progress has been made in improving the strains and the methods of cultivation of the staple crops.

We then motored to Peshawar, where we saw the University and the fine engineering laboratory which will soon be completed. We visited the Khyber Pass, the Malakand and Dargai power stations, and the site of the hydro-electric scheme on the Kabul River at Warsak which will produce both cheap electric power and irrigate some 65,000 acres of land on the North-West Frontier, making it available for cultivation by the frontier tribes. Financial assistance from Canada under the Colombo Plan will enable work on this site to start at once.

We were greatly impressed by the progress which is being made in the North-West Frontier Province under the dynamic leadership of the Chief Minister, Abdul Qayum, in education, hospitals, rural electrification and factories for the processing of agricultural products, like the sugar refinery at Bialpur. We went next to Rawalpindi to see the hill station at Murree, the Himalayan forest, and the ruined city of Taxila, with its fine Romano-Buddhist museum under the curatorship of Mr. Harundur Rashid.

In Karachi we saw the new University in its improvised home, the laboratories of the Department of Scientific and Industrial Research, where important researches have already started without waiting for full equipment, the Central Testing Laboratory, and the Cotton Research Institute. During our visit we were impressed by the excellent work which is being done in various centres by the British Council.

The most urgent problems of Pakistan, apart from her food shortage, seem to be supplies of irrigation water, drainage and electric power. These are all inter-connected, and it is to be hoped that the negotiations with the World Bank will soon result in engineering works for the control of the headwaters of the Indus, which could provide both perennial irrigation and ample power. The experience of irrigated zones in Egypt and Arizona suggests, however, that the problem of the salting up of the soil, which is becoming increasingly serious, will only be met by extensive drainage systems.

The Pakistan Academy of Sciences

In the afternoon of the first day of the Conference, February 16, we were present at the inauguration of the Pakistan Academy of Sciences, by the Prime Minister of Pakistan, Al-Haj Kwaja Nazimuddin. He spoke of the heritage of scientific and cultural achievement in Muslim history and of the dark Middle Ages of the West, when Muslim scientists kept the spirit of scientific inquiry alive. The Government recognizes, he said, the importance of pure scientific research as the bed-rock of all important forms of development, and it welcomes the establishment of the Academy, which was destined to play a vital part in the life of the nation.

The nine Foundation Fellows of the Academy were then presented to the Prime Minister, and they later elected the following office-bearers: *President*, Prof. M. Afzal Husain, formerly vice-chancellor of the University of the Punjab; *Secretary*, Prof. M. Raziuddin Siddiqui, director of research, University of Peshawar; *Treasurer*, Dr. Bashir Ahmad, vice-chancellor of the University of the Punjab. The other Foundation Fellows are: Dr. Nazir Ahmad, chairman, Tariff Commission, Pakistan Government; Dr. S. Siddiqui, director, Scientific and Industrial Research, Pakistan Government; Dr. M. Qudrat-i-khuda, scientific adviser, Ministry of Defence, Pakistan Government; Dr. M. Ishaq, principal education officer, Pakistan Military Academy; Dr. H. K. Bhatti, chairman, Department of Zoology, University of the Punjab; and Dr. M. Sharif, professor of zoology, Government College, Lahore.

The aims and objects of the Academy had been defined as the promotion of research in pure and applied sciences by means of publications, by the establishment of scientific libraries, laboratories, museums and research institutions, and by awarding grants, scholarships, fellowships, prizes and medals for research. The Academy will act as the National Research Council of Pakistan, for undertaking such scientific work of national or international importance as it may be called on to perform by the public and the Government. It will offer advice on all scientific matters to the Government and will represent internationally the scientific work of Pakistan.

Not more than five ordinary Fellows, distinguished for their original contributions to science, will be elected into the Academy each year until the limit of a hundred is reached. Eminent scientists of foreign countries will be elected as foreign members. These will be limited to thirty in number.

The Academy has already started work and plans are being prepared for the publication of *Proceedings* and research journals.

OBITUARIES

Prof. S. N. Winogradsky, For.Mem.R.S.

With the death on February 24 of Sergei Nikolaevitch Winogradsky, science has lost the greatest figure in soil microbiology. Winogradsky was born in Kiev in 1856 and spent his childhood there. He was a student in the University of Kiev and, later, that of St. Petersburg, where he studied chemistry and plant physiology. There, after graduation in 1881, he investigated the effects of nutrient supply and other environmental factors on the growth of the wine yeast *Mycoderma*.

This early work was one of the pioneer investigations on the effects of specific nutrients on micro-organisms grown in pure culture under adequately

controlled conditions. In 1885, Winogradsky moved to the University of Strassburg, where he became interested in micro-organisms concerned with the oxidation of sulphur and sulphides. He found that *Beggiatoa* was able to assimilate carbon dioxide, obtaining the necessary energy by oxidation of sulphur. This discovery started him on the classic series of investigations concerning autotrophic bacteria which opened up one of the most interesting fields in bacterial nutrition. He next passed to the study of the iron bacteria, some of which he claimed could similarly derive energy by the oxidation of ferrous iron.

Winogradsky went to Zurich in 1888 and in the following year began research on the problem of nitrification, that is, the oxidation of ammonium salts to nitrate. The importance of this process had already resulted in a search for the causative agents, and there was evidence that the process proceeded in two stages with the formation of nitrite and nitrate, and that the causative agents were biological. But attempts to isolate the responsible organisms had been unsuccessful. Winogradsky, with his experience of sulphur-oxidizing organisms, divined that those causing nitrification were also autotrophic, and he therefore used for their isolation an inorganic medium with a base of silica jelly. By this means he obtained two groups of autotrophic bacteria, one able to oxidize ammonium salts to nitrite and the other nitrite to nitrate. His investigation of the physiology of these organisms constitutes one of the classic researches in bacteriology. In 1891 Winogradsky returned to St. Petersburg, where he was appointed chief of the Division of General Microbiology at the Institute of Experimental Medicine. There he began work on a second soil process of fundamental importance in the economy of Nature, the fixation of atmospheric nitrogen. When he began this investigation, Hellriegel and Wilfarth had recently demonstrated symbiotic nitrogen fixation in the nodules produced by bacteria on the roots of leguminous plants. Winogradsky studied the gains in nitrogen of soil and showed the existence in it of an anaerobic organism, *Clostridium pastorianum*, that was capable of fixing nitrogen. This was the first non-symbiotic organism shown to possess this ability.

In 1905, after a period of ill-health, Winogradsky retired from scientific work and lived on his estate in Russia until 1921, when he finally left the country and, after a short stay in Switzerland, accepted the offer by the Institut Pasteur of a post and a laboratory at Brie Comte Robert, about twenty miles from Paris. During this phase of his work, he was much concerned with the difficulty in studying the micropopulation as it actually exists in the soil. He pointed out that most of the methods that were in common use consisted in isolating a number of organisms from soil and studying their behaviour under the unnatural conditions of the laboratory. He therefore devised methods for the purpose of investigating the micropopulation in the soil itself. In the first place, he developed and used a technique previously tried by H. J. Conn, namely, the microscopic examination of a film of soil suspension, dried and suitably stained to reveal the micro-organisms. Samples of soil with and without the previous addition of organic matter were thus examined. Winogradsky concluded from these observations that untreated soil contained a static micropopulation, but that the addition of decomposable nutrients caused the rapid increase in numbers of certain groups of organisms, the soil then passing from the static to the dynamic condition. A special example of this differential increase, that of *Azotobacter* in soil enriched with mannitol or starch, was investigated. This led to the invention of a method for detecting phosphate deficiency in soil, by observing the growth of *Azotobacter* colonies on the smoothed surface of a soil sample wetted to a thick paste after the addition of starch.

Another method developed by Winogradsky was that of sprinkling fine granules of soil on the surface of silica gel plates to which a specific nutrient had been added. He used this method for studying the development of colonies of *Azotobacter* arising from the soil granules. Later the method was used, with appropriate media, to obtain nitrifying organisms from soil. In the course of this further study of nitrifying organisms, several new genera were described. By similar methods, Winogradsky also studied aerobic soil organisms that attack cellulose, and made a special study of the Myxobacteria possessing this power, for which he proposed the generic name *Cytophaga*.

But his work at Brie Comte Robert, while yielding valuable new information on interesting groups of soil organisms, owes its main importance to his individual approach to the subject and to his constant aim at discovering what organisms were active in the soil itself and what were the conditions governing their activity therein. The methods that he developed all had this object in view. Indeed, throughout his life's work, Winogradsky showed an unequalled ability to devise experimental methods of elegant simplicity, but directly suited to the problem under investigation. This ability, together with the clarity of thought which characterized his work, enabled him to discover and develop new fields in bacterial physiology, particularly relating to specialized organisms of the greatest importance in the economy of Nature, and later on to change and enlarge our views on the ecology of the soil micropopulation.

H. G. Thornton

Prof. R. D. Laurie

Robert Douglas Laurie, whose death occurred on April 7, was born in 1874; he was educated at Birkenhead School. After a period on the staff of the Bank of Liverpool (1891–99), he studied in the Universities of Liverpool and Oxford, and was afterwards appointed to the staffs of the Zoology Department first of the latter and afterwards of the former. He remained at Liverpool for some years; but in 1918 he was appointed head of the Zoology Department in the University College of Wales, Aberystwyth, and was given professorial status four years later. He remained at Aberystwyth until his retirement in 1940.

Laurie's scientific work was of two main types. He published systematic reports on some Brachyura collected by Herdman in Ceylon in 1902 (Ceylon Pearl Oyster Fisheries Reports, 1906) and on the Anomura of Stanley Gardiner's *Sealark* Expedition (1926). After his appointment at Aberystwyth he took a keen interest in local problems of natural history—especially in the bottom-fauna of Cardigan Bay, and in the effects of pollution of certain Welsh rivers by lead. In collaboration with various colleagues he produced a number of reports on these

subjects, notably a paper (with Erichsen Jones) on the faunistic recovery of the Rheidol after lead-pollution (*Journal of Animal Ecology*, 1938).

As a professor, Laurie was genial, imperturbable, persistent in the face of difficulties, and regarded with sincere affection by students and colleagues. His personal characteristics—he was like a cheerful robin—gave rise to a whole series of tales (true and legendary) which in time constituted a veritable collection of affectionate 'Lauriana'. His unflagging attempts to develop his department, including a phase during which he and his students built a lecture-room with their own hands, were prevented by fate and the Second World War from reaching full fruition by the time of his retirement.

It was not, however, Laurie's activities as a zoologist or as a professor which will be remembered as his leading contribution to the welfare of his subject or his colleagues. The outstanding interest of his later years, and his chief service, lay in the field of organizations designed to promote the interests of university teachers and of university and educational affairs in general. It was Laurie's unfailing zeal, more than that of any other single person, which brought into existence the Association of University Teachers. He was its first president, in 1919, and was its honorary general secretary from 1920 to the time of his death. In addition (1943–53) he was honorary secretary-general to the International Association of University Professors and Lecturers, and it was at a conference of this organization that he died, after flying to Amsterdam, at the age of seventy-eight. Much of the credit for the achievements of these organizations may be traced back to Laurie's energy and enthusiasm. His educational interests were revealed in other ways, as in his reports for a British Association committee on the position of animal biology in the school curriculum; and he was responsible for the introduction of biological teaching in the grammar schools of Wales.

Laurie married Elinor Beatrice Ord in 1912, and both she and his daughter survive him. Mrs. Laurie has also for many years been beloved, not only by her family, but also in no common degree by her many friends, including those connected with her husband's enterprises.

T. A. Stephenson

Dr. T. A. Jaggar

Dr. T. A. Jaggar, dean of American volcanologists, died in Honolulu on January 17, just one week before his eighty-second birthday. Born in Philadelphia, Pennsylvania, on January 24, 1871, Thomas Augustus Jaggar, jun., was trained in public and private schools, and in 1893 received the degree of bachelor of arts in geology from Harvard University. He remained at Harvard to take his M.A. degree in 1894, and then spent most of the next two years studying at Munich and Heidelberg. Returning to Harvard, he was awarded the doctorate of philosophy in 1897.

During 1895–1903, Jaggar held an appointment as instructor in geology at Harvard, and in 1903 he was made an assistant professor. In 1906 he became professor and head of the Department of Geology at the Massachusetts Institute of Technology. During the summers he was a member of the United States Geological Survey, working in the Black Hills region of South Dakota and adjacent parts of Wyoming, in the Yellowstone National Park region, and in Arizona. In 1901 he published, in the Annual Report of the Geological Survey, an important study of the laccoliths of the Black Hills.

Very early, Dr. Jaggar's interest turned to experimental geology, and the study of earth processes in the field. His visit to Martinique in 1902, to study the results of the catastrophic eruption of Mont Pelée, decided him to adopt as his life-work the field-study of geophysics. From that time forward his major interest lay in the fields of seismology and volcanology, with a strong emphasis on the humanitarian aspects of both. His aim was the saving of human lives and property through the prediction of earthquakes and volcanic eruptions, the design of suitably resistant structures for countries subject to frequent earthquakes, and development of methods of protecting communities from the ravages of lava flows, glowing clouds, and heavy ash falls. Although he took part in many expeditions, Jaggar was firmly convinced that the only satisfactory way of studying volcanoes was by means of permanent observatories, keeping continuous records.

In 1912, Dr. Jaggar established the Hawaiian Volcano Observatory, for the continuous study, by direct physical methods, of Kilauea and Mauna Loa volcanoes. This was made possible by money provided from the Whitney Fund of the Massachusetts Institute of Technology, and funds subscribed by a group of business and political leaders of Hawaii that had formed the Hawaiian Volcano Research Association. For more than forty years the Hawaiian Observatory has carried on its work, under the Massachusetts Institute of Technology and later under successive agencies of the United States government. Dr. Jaggar remained its director until his retirement, in 1940. He then became research associate in geophysics in the University of Hawaii, a position he still held at the time of his death.

Dr. Jaggar's contributions to the science of volcanology have been very great. Studies of the Kilauea lava lake demonstrated its complex nature, with a shallow pool of hot fluid lava lying on a semi-solid but mobile plug. Measurements ascertained the distribution of temperature in the lake, and the composition of the liberated gases was determined. Tumescence and detumescence of the volcanic structure were demonstrated, probably resulting from changes in magmatic pressure beneath. The entire picture of volcanic activity was augmented and clarified. Perhaps most important of all, however, was the development by Jaggar and his associates of methods of aerial bombing to deflect lava flows, and the concept of huge diversion barriers to protect cities or harbours from inundation by lava. Jaggar never lost sight of the fact that the real purpose of science is to serve mankind.

Gordon A. Macdonald

We regret to announce the following deaths:

Sir David Anderson, president during 1943–44 of the Institution of Civil Engineers, on March 27, aged seventy-two.

Dr. F. W. Edridge-Green, C.B.E., for many years special examiner and adviser to the Ministry of Transport on vision and colour vision, on April 17, aged eighty-nine.

Dr. G. F. Herbert Smith, C.B.E., formerly of the British Museum (Natural History), and honorary secretary since 1921 of the Society for the Promotion of Nature Reserves, on April 20, aged eighty.

NEWS and VIEWS

Royal Society: Foreign Members

THE following have been elected foreign members of the Royal Society: Louis Victor Pierre Raymond, Prince de Broglie (Paris), distinguished for his contributions to quantum theory; Marie Jules Constant Robert Courrier (Paris), distinguished for his contributions to endocrinology; Hermann Joseph Muller (Bloomington, Indiana), distinguished for his contributions to the chromosome theory of heredity; Wolfgang Pauli (Zurich), distinguished for his contributions to theoretical physics, in particular the formulation of the exclusion principle.

Lister Institute of Preventive Medicine: Appointments

PROF. W. T. J. MORGAN has been appointed deputy director of the Lister Institute of Preventive Medicine; Prof. Morgan is already on the staff of the Institute and is professor of biochemistry in the University of London.

Dr. B. A. D. Stocker has been appointed head of the newly created Guinness Unit for Microbiology at the Lister Institute. The establishment of this Unit, for the study of general microbiology, was made possible through the generosity of Arthur Guinness, Ltd. After a war career in the medical branch of the R.A.F.V.R., with which he served mostly in India and Burma, Dr. Stocker was successively demonstrator, lecturer and senior lecturer in the Department of Bacteriology and Immunology in the London School of Hygiene and Tropical Medicine. His research work has been directed mainly to bacterial genetics, particularly mutation-rates of flagellar antigens in *Salmonella typhi-murium*; and, during the tenure of a Commonwealth Fund Fellowship in the United States, with type transformation in *Pneumococcus* and with the transduction of genetic characters by bacteriophages in which he applied the discoveries of Zinder and Lederberg to the transduction of flagellar characters in *Salmonella*. Dr. Stocker is thirty-five.

Contributions of Science to Peace

IN his Alexander Wood Memorial Lecture for 1953, "Contributions of Science to Peace", delivered at Friends House, London, on February 18 (pp. 28; from the Fellowship of Reconciliation, 38 Gordon Square, London, W.C.1; 1*s*. 6*d*.), Prof. C. A. Coulson rejects equally the view that science alone can lead us into the world of peace or that science should be abandoned. Science, he said, will always be with us, and we can ignore neither the dangers nor the benefits it offers. There are ways in which science, by providing a better understanding of ourselves, can assist those who seek for peace. Analysis of statistical data presented by Quincy Wright in 1942 suggested that wars, of all sorts and sizes, differ qualitatively as well as quantitatively from personal quarrels and that there is no basis for the belief that the world learns by experience that war is foolish, or fruitless, or an anachronism out of which we are continually growing. It also suggests that the problems of peace are not just technological, but composite both of technology and morals. Directing attention to the way in which mankind lives continually on the brink of famine, Prof. Coulson concluded that only an enlightened scientific policy can deal constructively with situations of under-nourishment such as confront us, for example, in Persia or in the British Colonial Empire. Science, moreover, is required to improve world supplies of energy as well as of food, and Prof. Coulson referred particularly to the value which nuclear power might hold for the Middle East or India if developed there, as well as to the possibility of utilizing wind-power, the tides or solar energy. Science, properly directed and shared, he said, can help to build the defences of peace and to safeguard the freedom and spirit of men. In one sense the responsibility of the man of science does not differ essentially from that of anyone else: scientific workers are not necessarily wiser than their comrades in the use of science. Science alone is not enough; but Prof. Coulson, while welcoming the increasing concern of scientific workers with the social implications of science, did not advocate the adoption of some sort of Hippocratic oath for scientists. He suggested that what is needed is a new dedicated type of scientific worker who, recognizing the wholeness of life and the place of science in that wholeness, will not be deterred by danger or difficulty from seeking to further the contribution which science can render in shaping a new world.

British Agricultural History Society: Inaugural Conference in Reading

THE inaugural conference of the British Agricultural History Society was held at the University of Reading on April 13 and was attended by more than a hundred people representing a very wide variety of interests and professions from all over the British Isles. Sir James Scott Watson addressed the conference on "The Scope of Agricultural History", and Sir Frank Stenton spoke on "The Manor in English History". Later in the day, the conference had the opportunity of visiting the Museum of English Rural Life, University of Reading. The officers of the Society are as follows: *President*, Sir James Scott Watson (chief scientific adviser to the Ministry of Agriculture); *Treasurer*, Prof. E. Thomas (professor of agricultural economics, University of Reading); *Executive Committee*, Mr. Alexander Hay (*chairman*) (general secretary of the Association of Agriculture), Mr. Frank Atkinson (director of the Halifax Museums), Mr. John Cripps (editor of *The Countryman*), Mr. R. N. Dixey (director, Institute of Agrarian Affairs, Oxford), Mr. G. E. Fussell (author), Captain E. N. Griffith (president of the Agricultural Engineers' Association), Mr. Stuart Maxwell (National Museum of Antiquities, Edinburgh), Mr. W. E. Minchinton (lecturer in economic history, University College, Swansea), Mr. G. Ordish (Plant Protection, Ltd.), Mr. F. G. Payne (Welsh Folk Museum), Mrs. Joan Thirsk (senior research fellow in agrarian history, University College, Leicester) and Mr. R. Trow-Smith (*Farmer and Stockbreeder*). The main object of the Society, as outlined in the constitution, is to promote the study of the history of agriculture and rural economy, though it is not intended that the interests of the Society should be solely confined to the history of the British countryside. It is hoped that, by publishing a journal and holding occasional conferences, the Society will be able to bring together all those working on, or merely interested in, any aspect of rural history. Membership is open to all, the annual subscription being one guinea. Membership forms and copies of the constitution will be available shortly. All inquiries should be sent to the secretary of the Society, Mr. J. W. Y. Higgs, Museum of English Rural Life, 7 Shinfield Road, Reading.

Science Abstracts on Index Cards

From time to time the Editor of *Science Abstracts* is asked whether an edition printed on index cards can be produced; the reply has hitherto been that the high cost of production and the limited circulation of such an edition would make the subscription-rate prohibitively high—in the neighbourhood of £40 per year for Section B (Electrical Engineering) alone. As an alternative, an edition printed on one side only was made available for anyone wanting to compile a card index of abstracts. However, a recent survey has shown that the labour of cutting and mounting single-sided issues may, in fact, raise the overall cost to a figure comparable with that of a card edition, which would, if so, be preferable for other reasons. Naturally, no precise estimate of the subscription for a card edition can be made until the probable extent of the circulation is known. To enable such an estimate to be made, the Editor of *Science Abstracts*, Institution of Electrical Engineers, Savoy Place, London, W.C.2, would be glad to hear from those willing to subscribe up to £40 per year for *Science Abstracts*, Section B, printed on index cards, 3 in. × 5 in. A similar card issue of Section A (Physics) could also be contemplated if sufficient demand was known to exist.

Southern Regional Council for Further Education

The fifth annual report of the Southern Regional Council for Further Education shows that, besides its regional academic board, many industrial and advisory committees have been set up since the Council was established in 1947. Most of the work of the advisory committee is concerned with trying to reconcile the requirements of industry, the requirements of students and the economic provision of further education facilities. Among the Council's activities during 1952 have been the sponsoring of courses in teaching methods which have been arranged for technical and commercial teachers. A number of conferences have also been arranged to make recommendations on metallurgical education facilities required in the region, and to discuss facilities for training agricultural craftsmen and young men in the heating and ventilating engineering industry. The Council has also published papers on the future development of higher technological education; the education and training of technologists in engineering, building, physics, chemistry and agriculture; recruitment of staff for technical colleges; instruction of rural craft workers; courses for building craftsmen; part-time instruction for agriculturists, horticulturists and domestic producers; agricultural education; and education for industrial citizenship.

Extra-mural Function of Universities

In an address to the Liverpool Branch of the Association of University Teachers, Mr. Thomas Kelly, the director of extra-mural studies in the University of Liverpool, indicated that the extra-mural task of a university is to make the maximum impact on the region within which it stands. The means will vary—classes; lecture courses, long and short; single lectures, recitals; exhibitions—all will have their place. In the vocational field, the university should limit its extra-mural provision to work which cannot easily be provided by other agencies; in the non-vocational field, it should seek to make provision for all groups able to profit by its services. Standards will look after themselves if the right tutors are appointed. This is the crux of all extra-mural work, and all tutors and lecturers need to be people of special qualifications. Because of this, the extra-mural resources of a university are necessarily limited, and the major task of an extra-mural department is the organization of these scarce resources in the most effective manner. A secondary task is that of studying the history, theory and techniques of adult education itself, and providing facilities for the training of tutors (*Univ. Rev.*, **25**, No. 2; February 1953).

International Congress on Electroacoustics

An International Congress on Electroacoustics will be held in the Netherlands during June 16–24 under the auspices of the International Commission on Acoustics of the International Union of Pure and Applied Physics. The Congress will open in the Hague on June 16 and on the following day will move to Delft, where most of the technical sessions will be held, but there will also be technical sessions (and excursions) in Hilversum and Eindhoven. The Congress will be made up of seven sections, each with a chairman who will give a general review of recent developments in the field (so arranged that all members will be able to be present), and these reviews will then be followed by individual papers and discussions. The sections, with the chairman shown in brackets, are as follows: (1) sound recording (R. Vermeulen, Netherlands); (2) public address systems (E. Meyer, Germany); (3) acoustic measurements (L. L. Beranek, United States); (4) hearing-aids and audiometers (P. Chavasse, France); (5) electro-acoustics in ultrasonics (G. Bradfield, Great Britain); (6) electroacoustics applied to musical instruments (E. G. Richardson, Great Britain); and (7) sound insulation of light-weight structures (C. W. Kosten, Netherlands). The last-named section will be in the form of a symposium. The official languages of the Congress will be English, French and German. Summaries of the papers will be circulated in advance. Application forms for membership and further information can be obtained from P. A. de Lange, Organizing Secretary of the Electroacoustics Congress, Mijnbouwplein 11, Delft.

Chemical Meetings in Paris during June

The second Salon de la Chimie will be held during June 18–29 in the Parc des Expositions, Paris, in conjunction with the next session of the Rassemblement des Arts Chimiques. The Salon will be organized by the Société de Chimie Industrielle, which this year will hold its twenty-sixth international congress of industrial chemistry during June 21–27 as a part of the Salon; other chemical bodies will similarly profit by the occasion by holding meetings at the same time, among which will be the following: the second session of chemical engineering, the seventh international congress of æsthetics and cosmetology, and the second symposium on proximate and functional analysis. The Salon will be divided into five sections: laboratory work and apparatus; chemical engineering; raw materials and products; organization, documentation, hygiene, etc.; and plastics. Further information of all these events can be obtained from the Secretary of the Société de Chimie Industrielle, 28 rue Saint-Dominique, Paris 7e.

Commonwealth Fund Fellowships for Study in the United States

The Commonwealth Fund has awarded fellowships, tenable in American universities for one year

beginning next September, to the following British graduates, among others: W. G. Chaloner, University of Reading (palæobotany); R. I. Gillespie, University College, London (chemistry); H. L. Kornberg, University of Sheffield (biochemistry); D. D. Mears, King's College, London (engineering); P. G. Moore, University College, London (statistics); E. A. Power, University College, London (physics); G. C. Shephard, University of Birmingham (mathematics); R. J. Tayler, Clare College, Cambridge (astrophysics); D. G. Verney, University of Liverpool (sociology); and J. M. Williams, St. John's College, Oxford (chemistry). In addition, Dominion Civil Service Fellowships have been awarded to H. P. A. De Boom, South Africa (veterinary science), J. J. Kitshoff, South Africa (economics) and M. J. Moriarty, New Zealand (agricultural economics); and Colonial Civil Service Fellowships to F. A. Loyd, Kenya (conservation) and C. S. Ramage, Hong Kong (meteorology).

"Protection from the Effects of Radiation"

COMMANDER P. L. CHANDLER, writing from 50 Montgomery Road, Sheffield, 7, says: "In *Nature* of February 28, p. 378, certain remarks are attributed to me, the nature of which I wish to disclaim. The policy of protection of personnel in the Naval Ordnance Inspection Department is not determined by the 'delivery of the goods'. The regulations laid down by their Lords Commissioners to the Admiralty are strict and conform to recommendations as accepted throughout the radiological world. These regulations as laid down are fully complied with in the Naval Ordnance Inspecting Department and those in force are such that the very minimum dose is obtained by personnel employed in the Radiological Department, and this is confirmed by daily readings with ionization chambers and regular readings by N.P.L. film batches".

Announcements

SIR ROBERT ROBINSON, Waynflete professor of chemistry in the University of Oxford, has been awarded the Priestley Medal of the American Chemical Society, the Society's highest award.

SIR JOHN LENNARD-JONES has been awarded the Hopkins Prize of the Cambridge Philosophical Society for his work on the mathematical theory of molecular structure. The Prize is awarded every three years to a member of the University of Cambridge adjudged to have published the best original work in connexion with mathematico-physical or mathematico-experimental science in the relevant three-year period. The present award is intended to refer to the period 1945–48. The first recipient was Sir G. G. Stokes in 1867.

THE COUNCIL of the Institute of Metals has elected Sir Arthur Smout (past-president) a Fellow, in recognition of his long and distinguished services to the Institute; the number of Fellows is limited to twelve. Sir Arthur Smout was chairman during 1934–42 of what is now known as Imperial Chemical Industries, Ltd., Metals Division.

MR. DAVID P. RAMSOME, a descendant of Robert Ramsome, the well-known agricultural engineer, and managing director of E. H. Bentall and Co., Ltd., has been elected president for 1953–54 of the Institution of British Agricultural Engineers.

DR. W. IDRIS JONES, director-general of research to the National Coal Board, has been elected president of the Institute of Fuel for the session 1953–54; he will succeed the retiring president, Dr. G. E. Foxwell, in October.

THE following appointments have been made in the University of London: Dr. L. F. Lamerton to the readership in physics applied to medicine, tenable at the Institute of Cancer Research, Royal Cancer Hospital; Dr. Miles Weatherall to the University readership in pharmacology, tenable at the London Hospital Medical College.

DR. S. F. MASON, formerly of Wadham College, Oxford, has been appointed a Research Fellow of the Department of Medical Chemistry of the Australian National University; he took up his duties on April 1 in the Department's laboratories, which are at present at 183 Euston Road, London, N.W.1.

THE fifth annual symposium on phytopharmacy, organized by a number of Belgian and Dutch organizations and companies interested in this field, will be held in the Institute of Agronomy, 233 Coupure, Ghent, on May 5. The majority of the papers will be in Dutch or French. Further information can be obtained from the secretary, R. H. Kips, Rijkslandbouwhogeschool, Coupure 233, Ghent.

THE Scientific and Technical Group of the Royal Photographic Society is organizing a conference on "Photographic Science and Technique", to be held in the Arthur Worthington Hall, University of Manchester, on May 16. A number of short papers will be read, with subsequent discussion, on some problems and uses of photography in scientific, industrial and medical work. The conference will be open to all; those who hope to attend should inform the Group Honorary Secretary (D. H. O. John, 62 Chelmsford Road, Shenfield, Brentwood, Essex), from whom further information can be obtained.

THE Society for Endocrinology is arranging a symposium on "The Determination of Adrenal Cortical Steroids and their Metabolites", to be held at the Medical Society of London, Chandos Street, W.1, on May 21 at 9.30 a.m. Non-members of the Society wishing to attend should write to Prof. N. F. Maclagan, Westminster Medical School, London, S.W.1. The Society also announces that a lecture on "The Prostatic Glands as Targets for Steroids" will be given by Dr. Charles Huggins (Ben May Laboratory for Cancer Research, University of Chicago) at the Royal Society of Medicine, Wimpole Street, London, W.1, on June 23 at 5.30 p.m. Admission is free and without ticket.

A COURSE on "Geography and Food Resources", to be held at Westham House Adult Residential College, Barford, near Warwick, during May 22–26, has been arranged by the Association of Agriculture with the co-operation of Captain F. Owen, principal of Westham House. After an opening talk on factors limiting world food production, other lectures will deal with land use and agricultural geography of Great Britain, the Dominions, Europe and the tropics. The fee for the course, which is residential, is £3 12*s.* 6*d.* Applications should be addressed to the General Secretary, Association of Agriculture, 238 Abbey House, 2 Victoria Street, London, S.W.1, from whom further details can be obtained.

ERRATUM. In the account of the Bose Institute, Calcutta, in *Nature* of March 14, p. 468, the director was referred to as Dr. R. C. Mazumdar. This should read Dr. D. M. Bose.

ELASTICITY IN LIQUIDS

A SYMPOSIUM on elasticity in liquids, arranged under the auspices of the British Society of Rheology, was held on March 27 in the Department of Science of the Durham Colleges in the University of Durham. Mr. J. E. Caffyn organized the details of the meeting.

Prof. J. E. P. Wagstaff welcomed the members to Durham, and the morning session then opened with Prof. G. S. Rushbrooke in the chair. Dr. R. Roscoe first read a paper on elastic relaxation and flow in suspensions, in which he referred to the early experiments of Schwedoff on relaxing sols. The method involved placing a gelatine solution in a co-axial cylinder viscometer, suddenly applying a shear by twisting the torsion head which supported the inner cylinder and observing the stress on the system as it relaxed slowly. Schwedoff considered that the stress fell off exponentially; but later workers do not confirm this. Dr. Roscoe has found, however, by repeating their experiments, that departure from the exponential decay is a feature of viscometers with a wide gap between the cylinders. By writing down the flow equations for such an apparatus, he is able to deduce a form of decay for the stress which agrees with experiment.

In the second part of his paper, Dr. Roscoe discussed the relation between rate of shear and shear stress, under steady conditions. Equations of flow have been developed by a generalization of Maxwell's method, which reduce to Bingham's equation in the case of steady flow. The cause of observed departures from Bingham's equation was discussed.

Dr. S. Thornton, speaking on the rheological behaviour of some dispersions of solid particles in liquid media, considered the effect of particle concentration on the relative viscosity of suspensions of rigid non-flocculating particles, and he developed a general expression applicable not only to spherical particles, in agreement with Einstein's well-known equation, but also to non-spherical particles of a limited type over a limited range of concentration. After a brief review of the experimental work on this subject, he stressed the need for checking the absence of flocculation of the particles and for ensuring the validity of any corrections applied. He explained briefly the technique for measuring the absolute viscosity of thixotropic materials which do not exhibit elastic behaviour, and gave results for some special cases.

Dr. E. G. Richardson described some experiments now in progress on the relationship between shear and bulk viscosity. Stokes first deduced a formula for the absorption of plane waves in a gas, the theory making the coefficient (α) proportional to the square of the frequency (f) and the kinematic viscosity (ν). In many liquids α/f^2 is constant (with frequency) but has a value much greater than that of Stokes's formula, if the shear viscosity is substituted for ν. It has been suggested that the bulk, or dilatational viscosity, should be included in ν when the propagation of ultrasonic waves is concerned. One experiment, suggested by Eckart, for the determination of bulk viscosity is based on the mensuration of the acoustic streams in the neighbourhood of a vibrating source, and a study of this is being made using hot wires to measure the streaming velocities in various fluids at frequencies from 1 c./s. to 1 Mc./s. Another method is to study the absorption of ultrasonics in capillary tubes, wherein plane waves are propagated in the centre of the tube and shear waves in the acoustic boundary-layer near the walls. Some initial results in both experiments were quoted.

In the afternoon session, with Dr. J. G. Oldroyd in the chair, J. E. Caffyn and R. M. Underwood described a new method for delineating velocity profiles in visco-elastic liquids. This involves the delineation of the motion of isolated oil drops, suspended in the liquid under test flowing along a tube 1 cm. in diameter, by double-flash photography from two perpendicular directions. From the double exposure of the oil drop on the photograph, the velocity at different radial distances from the axis of the tube can be estimated (and incidentally any deviation from axial flow detected), and hence the velocity profile at the site of the photographs to be constructed. Examples in water (for calibration purposes) and in an ammonium oleate sol were shown. In the visco-elastic fluid the velocity distribution, in accordance with the theories of Oldroyd and of Reiner and Rivlin, is still parabolic.

The final paper, by Dr. A. S. Lodge, considered some theories of the Weissenberg effect, and dealt with the distribution of transverse pressure in a rotating cone-and-plate viscometer, when the interspace is filled with a visco-elastic liquid in which components of stress perpendicular to the direction of shear are set up. The paper was theoretical and dealt with the fluid in stationary laminar incompressible flow, for which the general stress determinant was constructed. The difference between stress components (zero in a Newtonian fluid) give rise to the Weissenberg effect, as Dr. Lodge showed. Having calculated these differences for various radial distances in the cone-and-plate apparatus, he can compare the theory with the measurements of Roberts, who erected a series of manometers from the centre to the rim of the cone above the rotating plate and so was able to measure the transverse (vertical) stress distribution in a number of visco-elastic liquids. In the discussion on this paper, Dr. K. Weissenberg pointed out that Roberts's experimental results agree with his own calculation of the stress distribution.

MATHEMATICAL ASSOCIATION

ANNUAL GENERAL MEETING IN SHEFFIELD

THE annual general meeting of the Mathematical Association was held in the University of Sheffield during April 8–11. At a reception given by the University on April 8, Dr. J. M. Whittaker, the vice-chancellor, welcomed the members, among whom was his father, Sir Edmund Whittaker, honorary member of the Association and president in 1919.

On April 9, following the business meeting, the president, Mr. K. S. Snell (Harrow School), gave his address, his subject being "School Mathematics To-day and To-morrow". Mr. Snell began with a speculation on the probable content of the school curriculum fifty years hence, suggesting that many topics now regarded as well outside the school range would by then have become commonplaces of the

grammar-school curriculum. He then went on to examine present-day tendencies, to discuss which items might be emphasized and which might be allowed to fall into oblivion. One way in which much time might be set free for the development of the school course in mathematics would be to reform the British weights and measures – those tables which demand for their acquisition a great deal of time and effort – and Mr. Snell made a strong plea for the adoption of a suitable metric system in Britain.

Prof. A. G. Quarrell (Department of Metallurgy, University of Sheffield) then gave a paper on "Metallurgy—Craft and Science", describing the combination of craftsmanship and scientific investigation required in the production of high-quality steel; by the courtesy of Firth Brown, Ltd., a colour film showing modern methods of steel production was shown to the audience.

On April 10 the proceedings opened with a discussion on "Infinity", in which Prof. A. G. Walker (University of Liverpool) elucidated the concept of infinite numbers, and Dr. C. Hamill (University of Sheffield) spoke on the meaning and place of infinity in geometry. In the succeeding discussion some members thought that a simple account of these topics might be presented to a sixth form; but others urged that this was a subject which should be reserved exclusively for the university course.

The next paper, "The Mathematics Division, N.P.L.: its Work and Equipment", was to have been given by Dr. E. T. Goodwin, the superintendent of the Mathematics Division in the National Physical Laboratory; in his absence, through illness, Dr. L. Fox, the deputy superintendent, spoke on this topic, describing the range of machines, from the hand-operated adding and multiplying machines up to the A.C.E. electronic computer. Dr. Fox also dealt with the part played by the mathematician in analysing and systematizing the problems submitted to the Division before handing them over to the computing machines.

In the afternoon of the same day, a long and lively discussion was held on a subject which has greatly concerned the Association in recent years: "From Primary School to Secondary School". The opening speakers were Mr. L. B. Birch (deputy director, Sheffield University Institute of Education), Mrs. E. M. Williams (principal, Whitelands Training College) and Mr. M. W. Brown (headmaster, Charlton Secondary School). It was urged that free activity is the only method which will enable the average child to understand the mathematical processes of the primary-school range; but some secondary-school teachers feared that the freedom of activity might encourage the child to avoid hard work and might lead to a state in which pupils arriving at the secondary school would not have the firm grasp of fundamentals required for the school programme. In return, it was argued that understanding must precede technical skill and that manipulatory techniques are much more rapidly acquired if genuine understanding and appreciation of mathematical principles have been fostered in the primary school. But no easy solution to the practical problem of applying modern ideas to classes of forty or fifty children was put forward. In the evening, Dr. S. Vajda (Admiralty Research Laboratory) gave a paper on the "Theory of Games", a subject which, initiated mainly by John von Neumann in the 1920's, has proved to have wide applications to economics and also to the highly important war-time study of operational research.

The final paper, on April 11, was by Mr. J. F. Hinsley (chief radiologist and physicist, Edgar Allen and Co., Ltd.), who chose as his subject "From Examination Question to Industrial Problem". Here Mr. Hinsley showed that certain familiar examination questions concerning the motion of a particle, usually thought of as possessing only academic interest, are in fact of very considerable practical value in the design and testing of cement-making machines.

The new president of the Association is Prof. T. A. A. Broadbent, of the Royal Naval College, Greenwich.

SCOTTISH BRANCH OF THE SCIENCE MASTERS' ASSOCIATION

ANNUAL MEETING IN EDINBURGH

THE Scottish Branch of the Science Masters' Association held its annual meeting during April 7–10 at the Heriot-Watt College, Edinburgh, under the presidency of Dr. H. G. Nisbet, principal of the College. In his address, on "Some Applications of Physics in the Fuel and Oil Industry", Dr. Nisbet described the various methods of cleaning and grading coal, using such principles as flotation and electrostatic attraction. The difficulty of efficient cleaning becomes greater as the size of the coal particles decreases, and he attributed much of the dirtiness of our coal to-day to the increased proportion of very small particles in coal won by modern mechanized techniques. Turning to liquid fuels, Dr. Nisbet explained how 'knocking' or 'pinking' is due to abnormal rates of flame propagation, which can be corrected by the use of suitable catalysts such as tetra-ethyl lead. He next dealt with the problem of making efficient use of the fuel resources of Great Britain, and ended with a plea for more chemical engineers who, by increasing this efficiency, could help the country to maintain its place as a leading industrial nation.

Mr. R. M. Sillito, of the University of Edinburgh, gave an excellent lecture-demonstration on "Sound in Schools", with special reference to the new Scottish Leaving Certificate syllabus. He ended by asking that school pupils should be trained in the habit of precise quantitative thinking, which, he maintained, is far more valuable as a basis for university work than mere factual knowledge.

Two consecutive lecture-demonstrations on "A Theoretical and Practical Approach to the Teaching in the M.K.S. System of Electrical Units" were then given by Mr. F. A. Meier, of the University of London Institute of Education. This again had special significance in view of the new Leaving Certificate syllabus, both as regards the M.K.S. system itself and also as regards the approach via electromagnetic induction instead of magnetometry. His demonstrations of home-made apparatus, much of it being designed on original principles, were most impressive. Mr. Meier stressed the point that the new system and approach are far easier than the old, provided we can rid ourselves of our preconceived notions.

In a lecture on "School Astronomy" given at the City Observatory, the director, Mr. N. G. Matthew, asked science masters to try to make time for some astronomy in an admittedly crowded syllabus, and outlined methods by which the subject

might be presented. He concluded by explaining a way in which senior pupils in Scotland can join in research by enrolling as members of the team of observers who are reporting on appearances of the aurora borealis. Mr. W. Fulton gave a demonstration of modern methods of sound reproduction, including tape-recorders. He ended by demonstrating a sound-film with a double sound-track—the original optical track, and a magnetic sound-track added later by a special process and giving entirely different sound. This very recent development may have great possibilities for such purposes as the addition of a translated commentary to foreign sound-films.

Prof. G. F. Marrian, professor of chemistry in relation to medicine, University of Edinburgh, gave a lecture on "Careers in Biochemistry". He outlined the history of biochemistry from a borderline-subject to one standing in its own right, and then went on to consider the problem of training, in which he expressed the view that an honours degree in chemistry or in biochemistry is of approximately equal suitability as a start; but, in addition, several years of research leading to a Ph.D. are practically essential. Prof. Marrian mentioned the openings for biochemists in universities, research units, hospitals and industry, and made a special plea for more biochemists to take up agricultural research in order to help improve the food situation in Great Britain. Finally, he said that the demand for biochemists is limited, the post-war shortage having been filled up; but for a few students of high standard there is an opportunity of working in a field of science which is developing very rapidly. In a lecture on "Some Recent Developments in Organic Chemistry", Dr. Neil Campbell, of the University of Edinburgh, first dealt with modern sources of organic materials and showed how petroleum is replacing coal-tar as the main source. Then he went on to discuss modern trends in theory and practice, including the theory of orbitals and the use of fluorescence and chromatography.

Other features of the meeting included the annual business meeting, visits to places of interest, exhibitions by members, publishers and manufacturers of scientific apparatus, and a glass-blowing demonstration by Mr. D. Macdonald, chief glass-blower in the Heriot-Watt College. A discussion was also held on "Recent Publications of the Scottish Education Department", which resolved itself largely into an expression of apprehension that the new syllabus in Circular 249 is too long to be covered in the time available at most schools, although it was conceded that the syllabus has great merits in other ways and should be given a fair trial.

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1951

THE report of the Rothamsted Experimental Station for 1951 shows that the station has again been the venue of a number of important conferences, that overseas visitors have been even more numerous than in previous years, and that the services of members of the Rothamsted staff continue to be sought by many different countries.

* Rothamsted Experimental Station. Report for 1951. Pp. 212. (Harpenden: Rothamsted Experimental Station, 1952.) 7s. 6d.

Field work with fertilizers, which has a primary place in the Rothamsted tradition, some of it in conjunction with other centres, is giving indications that some of the newer fertilizers, particularly silicophosphate, are likely to give good results. Nitrophosphates (formed by the action of nitric acid on rock phosphate and subsequent treatment with ammonia) consist essentially of ammonium nitrate and dicalcium phosphate, but there are some chemical and physical differences arising from different ways of production which appear to make some of them a little more effective than others. Two kinds examined at Rothamsted did not on the whole give quite the same yields as the same amounts of nitrogen and phosphate in sulphate of ammonia and superphosphate, but the results suggest that improvements in physical conditions can give a very useful nitrophosphate. Work with the older fertilizers is still giving positive suggestions, and some field results indicate that superphosphate may in some circumstances be used in much smaller dressings than have usually been advocated.

Other work in the Chemistry Department is concerned with the placement of fertilizers and with nutrition problems in forest nurseries.

Consideration of the relation of soils to ions in solution has been based by many workers on Gouy's double-layer theory, and the Physics Department has done very useful work by a critical examination that supports the justification for this use of the Gouy theory. This study is advancing our understanding of the behaviour of the aluminium ion, of the hydrogen-ion concentration in the soil-solution system and of the flocculating and deflocculating effects of salts. The Department is continuing its work on soil cultivation and its investigations in agricultural meteorology.

The study of clay minerals continues in the Pedology Department; the work has included examination of a number of African soils, and a study of the absorption of organic compounds by clays. Further results of the study of gleying in soils offer some interesting suggestions. The reducing power of fermenting plant material (dealt with in the 1950 report) is much in excess of the iron actually reduced in the soil, and the rate of solution of the ferric oxide seems to be the limiting factor. Mottling with iron rust, so common in many gley layers, is only present in old root channels: elsewhere there is only grey material that is characteristic of the reducing action in gleying.

In the Microbiology Department the important work on nitrification is being continued, and the study of antibiotics secreted by actinomyces is producing some interesting results which may well lead to economic applications. Some of the clay and humic matter acts as an absorbent of the antibiotic, and some organic matter may act as a nutrient to the actinomyces and as an absorbent of its antibiotic. Another interesting piece of work shows that some reductions in soils are not unnecessarily anaerobic, for sulphates can be reduced with the production of hydrogen sulphide by aerobic organisms.

Work in the Botany Department on the uptake of nutrients by roots has been going on for some time, and some of it has recently been published. The uptake of an element seems to depend on the carbohydrate content of the root and the concentration of the particular element concerned, but is not affected by the concentration of other elements in the root cell. These studies are now involving the use of

whole plants, and not merely excised roots, and should throw valuable light on an important and much-discussed subject. Further work on the spraying of leaves with nutrient solutions shows appreciable increase in growth following this treatment and sometimes, but not always, increases the percentage of nitrogen and phosphorus in the dry matter. Some work is being done on the possible replacement of potassium by sodium, and it has been shown, arising out of this work, that the effect of potassium deficiency on carbohydrate production does not account for the decrease in plant growth, since leaves sprayed with sucrose absorb the sugar without any increase in growth.

The Plant Pathology Department has continued its study of viruses and the influence of ultra-violet radiation on their effects. There is much other work on viruses and considerable mycological work, including some important observations on the spreading of spores.

The Biochemistry Department is carrying on the work on nucleoproteins from both normal and infected leaves. Rothamsted is giving up its responsibility in the technological production of leaf protein, which will now be carried on independently by the Grassland Research Station. The oxidation of manganese in certain plants is found to take place by the action of hydrogen peroxide forming in the plant under the influence of a peroxidase. A study of the parts of fungal mycelia that accumulate in soils in a very resistant form will contribute to our knowledge of the structure and properties of soil organic matter.

Different strains of eelworms that attack various crops and weeds are still being investigated in the Nematology Department, and immune varieties of crops are being sought.

Other work includes the study of insect populations, the feeding habits of bees, the effects of insecticides and the influence of insecticides on soil microflora. The Statistics Department continues to design experiments not only for Rothamsted but also for many other centres.

Some of the work (virus diseases in sugar beet, manganese oxidation in plants, and the movement of insects) are the subject of special reviews in this report, and the publication also contains, as usual, a brief report of the Soil Survey of England and Wales and a list of Rothamsted publications.

CHECK-LIST OF THE BIRDS OF GREAT BRITAIN AND IRELAND

THE scientific names of British birds have suffered from many changes, which has caused much inconvenience and some confusion. The British Ornithologists' Union has on three separate occasions, between 1883 and 1923, published lists of the birds on the British list with what were considered their correct scientific names. Unfortunately, however, the various authors responsible for these lists did not always pay strict attention to the International Rules of Nomenclature. Six years ago the Union decided that it was time a fresh list was prepared, and a committee was appointed; the new "Check-list of the Birds of Great Britain and Ireland" is the result of its labours*.

* Check-List of the Birds of Great Britain and Ireland. (Published by the British Ornithologists' Union.) Prepared by the List Sub-Committee. Pp. xii+106. (London: H. F. and G. Witherby, Ltd., 1952.) 7s. 6d.

The committee had three tasks before it: to decide on the correct scientific names; to investigate the claims of certain rare wanderers to be admitted to the British list; and to examine the twenty-nine races of British birds described since the publication of the previous list. Of these new races, twenty-four were described by one individual, and out of the total the committee has only been able to recognized six.

Most of the changes in scientific nomenclature are already in use, but the committee has made two innovations regarding the use of English names. In the first place, the English name is restricted to the species, and only in a few exceptional cases is one given for a race. The second change is that the name is given by which American birds (either regular visitors or rare wanderers to Britain) are known in Canada or the United States, as well as the recognized British name. For example, the peregrine falcon is called the duck-hawk on the western side of the Atlantic, and the grey phalarope is known as the red phalarope. The general distribution of both species and races is briefly given, and should be very useful to curators and others.

The committee is to be congratulated in bringing its labours to a satisfactory conclusion, and a word of praise is due to the secretary, who, together with the chairman, are the only original members of the committee. The president of the Union, Sir Landsborough Thomson, has written an admirable introduction, which users of the check-list should read carefully.

NATURE OF 'FIELD RESISTANCE' OF THE POTATO TO *PHYTOPHTHORA INFESTANS* DE BARY

By K. O. MÜLLER
National Institute of Agricultural Botany, Cambridge
AND
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ALL attempts have hitherto failed to find 'true resistance', that is, resistance by virtue of suprasensitivity (= hypersensitivity), to *Phytophthora infestans* in the European cultivated potato, and there is good reason for thinking that this form of resistance will not be found in any old-established cultivated variety, not even in South America from whence the potato was brought to Europe four hundred years ago. Suprasensitivity, however, to various biological strains of the parasite has been obtained in commercial varieties in recent years by German, British and American breeders, but only by crossing cultivated forms with *Solanum demissum* or other wild *Solanum* species which may possess this type of resistance. Nevertheless, it has been known for a hundred years that considerable variation can be observed among old-established varieties in the reaction to blight under field conditions. This variation of what may be called 'field resistance' is found in the time of the first appearance of the disease and in the speed with which it increases to epidemic proportions within the plot; further, there is correlation between the rhythm of development of the host and the epidemic behaviour of the parasite—the later the variety would mature under disease-free

conditions, the later, as a rule, the disease becomes epidemic.

This obvious relation between rhythm of development of the host and epidemic behaviour of the parasite, together with the fact that, under European conditions, blight generally reaches epidemic proportions not earlier than flowering time (therefore 'late' blight) has led many authors to the conclusion that blight is an "age-disease"; they have assumed that a "lowering of efficiency of immune reactions" takes place with increasing age and that this ontogenic change occurs much more quickly in early varieties than in late ones. There is, however, no conclusive experimental proof of such a change; moreover, under different climatic conditions—for example, in Turkey near the Black Sea or in many parts of Chile and in South Africa—blight often appears at epidemic proportions much earlier in the season; long before the plants reach the flowering stage.

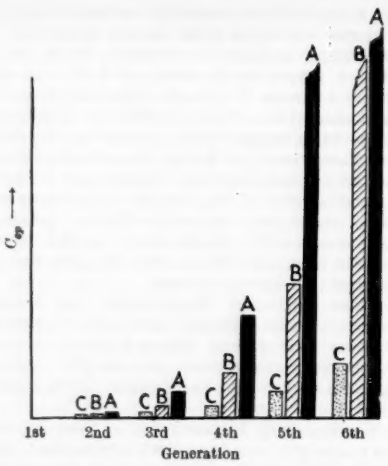
A new attempt to explain the observed facts is based on the following working hypothesis. Potato blight belongs to the group of airborne plant diseases. Under the climatic conditions of the major potato-growing areas of Europe, the parasite has to start at the beginning of each new season from comparatively small foci of infection, and it takes a relatively long time for the disease to reach epidemic proportions (numerous observations of one of us (K. O. M.) indicate that at least five generations of the parasite are necessary to infect a larger plot from a few primary foci of infection). Supposing that the spread of sporangia within the plot is homogeneous and their increase according to geometrical progression, the infestation of a plot is assumed to proceed according to the following formula:

$$C_{ep} = (c.P_I)^n,$$

where C_{ep} is degree of infestation, P_I is "probability of becoming infected per unit area of leaf", c is intensity of fructification per single leaf spot, and n is number of generations of the parasite since the initial infection.

This formula cannot reflect the actual situation within a field-plot; it can only illustrate the principle on which the working hypothesis is based. For example, it assumes that there is only one primary infection and that subsequent spread is internal; the assumption is justified on the grounds of mathematical simplicity by the heuristic character of the equation. Further, all the factors on the right-hand side of the equation are affected by constantly changing environmental conditions, particularly temperature and humidity. Also, since the epidemic effects of differences of P_I will be in inverse ratio to the number of spores hitting the foliage, we may expect the effect to be greater at the beginning of the blight attack than later; and for the same reason, the effect of P_I values on the rate of spread of the disease will vary directly with the distance of the plants from the source of infection.

Nevertheless, assuming that P_I would be the only factor in which three varieties A, B and C differ from one another, the differences being in the proportion $A : B : C = 100 : 75 : 50$, and that the density of sporangia sweeping over the plot is homogeneous, then the accompanying diagram illustrates the consequences which would follow from the working hypothesis. It indicates that considerable differences between the C_{ep} values of the varieties concerned are



to be expected after four generations of the parasite, and that these differences should increase with increasing age of the plant, so that variety A succumbs much earlier than varieties B or C. Conversely, since in early varieties blight usually appears earlier and increases faster to epidemic proportions, these varieties should have greater P_I values than late-maturing ones.

The technique used for testing this working hypothesis will be described in detail in a subsequent paper. Briefly, it consisted of inoculating fresh pieces of leaf of the same size with a weak zoospore suspension which was sprayed on them in dishes by means of an atomizer. The pieces of leaf were examined under the binocular microscope after four or five days and were 'scored' as 'diseased' or 'not diseased'. In the experiments here described a 'common' (A) strain of the parasite was used.

The arrangement of the pieces in blocks, with each variety or treatment equally represented and randomized in each block, made possible a statistical analysis of the results of inoculation. The degree of infection, measured for each variety by the number of pieces of leaf attacked (per block), was expressed as a percentage of the number of pieces inoculated (per block), and these percentages were converted by the $\sin^2\theta$ transformation before being subjected to an analysis of variance. These $\sin^2\theta$ figures, referred to as the R_I values, were used as a measure of the P_I values of the varieties. As an example, a test with field plants may be quoted in which there were four varieties: Champion, Stormont Dawn, Home Guard and King Edward. Each variety was represented by forty-four pieces of leaf, arranged in four blocks. Counts were made five days after inoculation and gave the following total numbers of pieces infected: Home Guard, 36; Champion, 14; King Edward, 41; and Stormont Dawn, 14. When the figures which contributed to these totals were expressed as percentages for each block and the percentages converted by the $\sin^2\theta$ transformation, the analysis of variance became possible (Table 1).

Differences are significant at the 1 per cent level and show Champion and Stormont Dawn to be significantly less infected than Home Guard or King Edward.

The essential experiments were carried out with twelve varieties grown at the National Institute of

Agricultural Botany in Cambridge during 1951. Unfortunately, blight appeared at epidemic proportions rather late in the year, the first being observed only in the second half of August. The names and abbreviations, maturity and reaction to blight infection in the field of the varieties used are given in Table 2.

During the period between the end of June and the middle of September, nine series of tests including all these varieties were made on pieces of leaf by the method just described. In Table 3 the results (mean values) of the four laboratory tests carried out between August 1 and 27 are plotted against the reaction of the varieties to blight in the field.

It will be seen from the table that there is correlation between the 'probability of becoming infected per unit area of foliage' (as measured by R_I) and the behaviour of the varieties in the field: the later blight appears and the more slowly it increases to epidemic proportions under field conditions, the smaller are the R_I values obtained in the laboratory. In Table 4 the results are plotted against the varieties arranged in order of maturity in the field, and there is again seen to be an orderly arrangement in which the chance of becoming infected increases with decreasing maturity of the variety.

Of all the varieties under trial, the latest incidence of blight in the field-plot and almost the lowest R_I values in the laboratory were shown by Champion, an old-established British variety which has been known as an outstanding 'blight-resister' for a long time. The results of these tests not only confirmed its field resistance, but also showed that the late incidence of blight in this and similar varieties is by no means the result of a belated lowering of efficiency of immune reactions with increasing age. On the contrary, there are strong indications that an ageing leaf becomes less susceptible to infection. The reason why the disease appears relatively late in the season in these varieties is largely because in them the probability of becoming infected (P_I) is relatively low, and in years when the disease occurs only in small proportions, these varieties will often escape severe attack.

Other experiments, to be described in detail in a subsequent paper, have shown that environmental conditions can affect the P_I value of a plant; for example, plants raised in the greenhouse will usually show a higher degree of infection than plants grown in the field. It has also been found that there are no significant varietal differences of R_I values if the spore suspension is sprayed on to the lower surfaces of the pieces of leaf, indicating, among other things, that natural infection usually takes place on the upper surface of the leaf. Evidence in support of the existence of differences in the factor c in the formula $C_{ep} = (c.P_I)^n$ will also be presented. Finally, the experiments showed that the factor or factors which control the 'chance of becoming infected' are independent of the strain of *Phytophthora* which is used for the determination of R_I values, indicating that such factors are different from those which confer resistance due to suprasensitivity. The potato breeder who wishes to obtain the highest possible degree of blight resistance in his breeding material should therefore combine both qualities by crossing varieties with low P_I values and suitable maturity with those which possess 'true resistance' by virtue of suprasensitivity.

We wish to acknowledge the assistance received from Miss M. Kostrowicka in carrying out numerous P_I tests and in observing the behaviour to blight of the field plots at the National Institute of Agricultural Botany during 1951.

Table 3

Field observations		$\sin^2\theta$ (mean values) 20·0–24·9	25·0–29·9	30·0–34·9	35·0–39·9	40·0–44·9	45·0–49·9
Resistant ↑	1	CH.					
	2	ST.D.					
	3			U.S.	K.E.		
	4		A.V.				
	5				M.		
	6					U.EM.	
↓ Susceptible	7				B.H.G. U.CH.	U.EN.	A.P.

Table 4

Order of maturity		$\sin^2\theta$ (mean values) 20·0–24·9	25·0–29·9	30·0–34·9	35·0–39·9	40·0–44·9	45·0–49·9
Early ↑	*A*				U.CH. H.G.	U.EN.	
	B				B.	U.EM.	A.P.
	C				K.E. M.		
	D	CH.	A.V.				
↓ Late	*E*	ST.D.		U.S.			

Table 1

Variety	Block 1	Block 2	Block 3	Block 4	Totals	Mean
Champion	25·3	47·6	17·6	42·4	132·9	33·2
Stormont Dawn	37·1	37·1	31·5	31·5	137·2	34·3
Home Guard	64·7	72·4	64·7	58·5	260·3	65·1
King Edward	72·4	90·0	72·4	72·4	307·2	76·8
Totals	199·5	247·1	186·2	204·8	837·6	52·3

Table 2

Name	Maturity		Behaviour to blight	Abbreviations used in Tables 3 and 4
Ulster Ensign	First early	*A*	7	U.EN.
Ulster Chieftain	" "		7	U.CH.
Home Guard	" "		7	H.G.
Arran Pilot	Second early	*B*	7	A.P.
Ulster Emblem	" "		6	U.EM.
Bintje	" "		7	B.
Majestic	Early main-crop	*C*	5	M.
King Edward	"		3	K.E.
Arran Viking	Main-crop	*D*	4	A.V.
Champion	"		1	CH.
Ulster Supreme	Late main-crop	*E*	3	U.S.
Stormont Dawn	" "		2	ST.D.

7 = most early appearance and quick increase of the disease
1 = latest appearance and slow increase at the end of the season

EFFECT OF NERVOUS STIMULATION ON THE ARTERIO-VENOUS OXYGEN AND CARBON DIOXIDE DIFFERENCES ACROSS THE KIDNEY

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THE kidney usually receives about 25 per cent of the cardiac output[1] and thus probably has far more oxygen available than it can extract under ordinary metabolic conditions. This same high rate of tissue-flow greatly dilutes the carbon dioxide returning to the circulation, in relation to other tissues. Normally, therefore, the arterio-venous differences of these gases are small, and any changes produced in them experimentally are even smaller in absolute value. Indeed, attempts to increase the osmotic reabsorptive work of the kidney have produced no measurable change in oxygen utilization[2], and change in oxygen uptake seems to correlate best with blood flow[3]. Consequently, measurable changes in arterio-venous differences may be taken to indicate changes in blood flow rather than tissue oxygen consumption. The work reported here is an attempt to use gaseous differences across the kidney as a measure of the changes in renal blood-flow produced by nervous stimulation.

Fourteen adult cats were used under 'Nembutal' anæsthesia, 30 mgm./kilo administered half intraperitoneally, half intramuscularly. Arterial blood samples were drawn from the femoral artery, while renal blood was collected through a No. 5 or 6 straight cardiac catheter, passed from the internal jugular vein in the neck into the left renal vein with the aid of a fluoroscope. The left renal vein was used because it joins the vena cava at a more acute angle than the right and is longer, thus providing more mechanical security for the catheter position during the experiment. The position of the catheter was verified in each case by post-mortem examination. All blood samples were drawn under oil in heparin-moistened syringes and analysed directly. Urine flow, when measured, was obtained through an in-dwelling catheter in female cats.

Systemic blood pressure was measured with a mercury manometer attached to a carotid cannula.

The portions of the nervous system stimulated were: (*a*) the central end of the severed sciatic, (*b*) peripheral end of the cut splanchnics (exposed by a dorsal approach to the crus of the diaphragm) and (*c*) the supraorbital areas of the cerebral cortex (exposed by superior craniectomy and retraction). The peripheral points were stimulated by means of a thyratron discharge at a frequency of 150/sec.; cortical stimulation was carried out with a 10/sec. square wave of 10 m.sec. pulse-width produced by a multivibrator.

The orbital surface was chosen for cortical stimulation upon the evidence presented by Ward and McCulloch[4] that there are direct unmyelinated connexions from this area to the head ganglia of the sympathetic nervous system in the posterior hypothalamus. The supraorbital surface was just lateral to the posterior third of the olfactory nerve on the concave under-surface of the cat's brain. Renal vein catheterization was completed before craniectomy in every case, so that the effects of the rongeuring of cranial bone could be determined immediately after exposure.

The effects of stimulation on arterio-venous oxygen and carbon dioxide differences are shown in the accompanying table. Oxygen figures are expressed as an arterio-venous difference, while carbon dioxide appears as a venous-arterio difference. The direction of change was the same in every animal with every stimulation, and the figures presented are averages of the differences. The changes are compared with pre-experimental levels determined in triplicate over a half-hour period. The peripheral stimulations were applied for 5 min. continuously. In the case of the sciatic stimulation a drop of about 50 per cent was produced in both gaseous differences. After a period of 10–30 min., the original levels had either been restored or had been exceeded. This phenomenon was easily repeatable in the same preparation, if a rest period of at least 30 min. was allowed between successive stimulations. The figures show that splanchnic stimulation produced a slightly greater change than sciatic stimulation in the same direction. The time relationships of stimulation were also similar. The effects of craniectomy are listed separately: both gaseous differences were depressed slightly, and the depression tended to continue for some time after exposure. This depressed value was taken as the base-line for the subsequent stimulation, which produced a further parallel decrease in both differences of long duration. No significant recovery occurred in most cases by 45 min. after stimulation had ceased.

Urine production completely ceased with the onset of all stimulations and gradually returned during the subsequent period. The restoration of the flow of urine usually coincided with the recovery of gaseous differences. Systemic blood pressure rose sharply in response to peripheral stimulation, but fell again to its original base-line value usually by 30 sec. after stimulation had been initiated. In response to cortical stimulation the rise (20–40 mm. mercury) of systemic blood pressure was slower (1–2 min.) and the decline showed a similar time course.

Supraorbital stimulation, in contradistinction to all the others attempted, produced an effect of long duration, which may be due to continual firing from a hypothalamic circuit, or a cortico-hypothalamic reverberation, or both. It is unlikely that the differences in duration of response are due to end-organ characteristics, since other nervous pathways to the kidney produce a shorter response. Other cortical stimulations[5] have produced similar results.

The respiratory quotient of the kidney remained at about 0·90–1·00 before and after stimulation, so that the kidney appeared to be burning mainly

Gaseous Differences Across the Kidney during Stimulation

	Gas	*A*	*B*	*C*
Sciatic	Oxygen	3·0	1·4	3·6
	Carbon dioxide	2·9	1·3	3·5
Splanchnic	Oxygen	3·3	1·2	3·8
	Carbon dioxide	3·5	1·8	3·5
Craniectomy	Oxygen	4·1	3·9	3·9
	Carbon dioxide	3·8	3·5	3·5
Supra-orbital cortex	Oxygen	3·9	2·7	2·8
	Carbon dioxide	3·5	2·2	2·3

A = before stimulation; *B* = during stimulation; *C* = after stimulation

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carbohydrate, and stimulation had little effect on this process.

The decreases in arterio-venous oxygen and carbon dioxide differences reported here would indicate either an increased total flow, or a decreased distribution of flow, or both. A decreased distribution of flow would be followed by an increased flow in the non-compromised portions, if the total flow remained constant. An example of this is the by-pass described by Trueta *et al.*[6]. Cessation of flow of urine may be attributed to a decreased effective blood supply to glomeruli and tubules by direct afferent arteriolar vasospastic action. Such an afferent arteriolar change would also produce the suggested redistribution or redirection of flow within the vascular network and is in agreement with recent clearance data[7] showing the renal response to stimulation.

I should like to express my gratitude to Profs. D. H. Barron and J. F. Fulton for direction and advice, and to Prof. R. A. McCance, who aided in the preparation of this communication. The fluoroscopy unit was lent by Dr. Samuel Gelfan. This work was financed by a grant from the Therapeutic Research Committee of the American Medical Association.

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CALCULATION OF ELECTRON-DENSITY DISTRIBUTION IN CRYSTALS WITH THE HELP OF CONVOLUTION OPERATIONS

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THE electron density distribution ρ_∞ of an infinitely large crystal is usually represented by a Fourier series,

$$\rho_\infty(x) = \frac{1}{v_r} \sum_h^\infty f(b_h) \exp 2\pi i(b_h x), \qquad (1)$$

where $$b_h = h_1 b_1 + h_2 b_2 + h_3 b_3, \qquad (2)$$

and $$b_1 = \frac{[a_2 a_3]}{v_r}, \quad b_2 = \frac{[a_3 a_1]}{v_r}, \quad b_3 = \frac{[a_1 a_2]}{v_r} \qquad (3)$$

and $$v_r = (a_1 a_2 a_3) = \frac{1}{(b_1 b_2 b_3)}.$$

a_1, a_2, a_3 and b_1, b_2, b_3 are the three fundamental-vectors of lattice cells having the volume v_r in physical space and $1/v_r$ in Fourier space, (bx) denotes the scalar product of radius vectors x and b in physical and reciprocal spaces respectively, the Miller indices h_1, h_2, h_3 are integers and b_h represents the co-ordinate of the reciprocal lattice point h. The Fourier coefficients $f(b_h)$ are known as structure amplitudes; they are, in general, dimensionless complex numbers, but are real for ρ_∞ having a centre of symmetry. Only the magnitude $|f(b_h)|$ is obtained experimentally from the integral intensity of the crystal reflexion lying at b_h. The difficulty and uncertainty of determining $f(b_h)$ itself from the $|f(b_h)|$ value are well known in classical X-ray crystallography (cf. Hosemann and Bagchi[1]). As in Fourier analysis, here it will also be asumed that the problem of the determination of phases has been satisfactorily solved, and $f(b_h)$ values are known. Even then, the calculation of ρ_∞ with the help of eq. (1) is a laborious task, and various methods and machines have been suggested to lighten this burden (cf. Booth[2] and Nowacki[3]). Moreover, so calculated, ρ_∞ has the following disadvantages.

(*a*) It is very difficult (if at all possible) to discuss the errors involved in the calculated ρ_∞ resulting from errors in measured values of $f(b_h)$.

(*b*) Since experimentally only the reflexions lying within the sphere

$$|b_h| < 2/\lambda \qquad (4)$$

can be measured, λ being the wave-length of X-rays, the number of terms in eq. (1) would be at most

$$H = \frac{4\pi}{3}\left(\frac{2}{\lambda}\right)^3 v_r. \qquad (5)$$

Thus, the calculated

$$\rho_{\text{Abb.}} = \frac{1}{v_r} \sum_{h=0}^{H} f(b_h) \exp 2\pi i(b_h x) \qquad (6)$$

shows contour lines of equal electron-density distribution which are different from those of true ρ_∞. This distortion due to the termination of series ('Abbruch effect') cannot be exactly calculated with the help of existing methods. But this is particularly important in view of the fact that the distortion is most marked in the region (as has been shown here) which is likely to offer valuable information about the nature of valence bonds.

(*c*) This 'Abbruch effect' also causes a displacement of the co-ordinates of the atoms, which cannot be exactly calculated.

The following method of calculation overcomes or reduces all these difficulties, since here the major portion of the intensity is treated with the convolution operation to give a $\rho(x)$, and the few remainder terms, when not negligible, can be treated in the usual way of Fourier synthesis.

Let $P^1(b - b_h)$, $P^1(x - x_a)$ denote point functions such that

$$\begin{aligned} P^1(b - b_h) &= 0 \quad \text{for } b \neq b_h \\ P^1(x - x_a) &= 0 \quad \text{for } x \neq x_a \\ \int P^1(b - b_h)\mathrm{d}v_b &= 1 \\ \int P^1(x - x_a)\mathrm{d}v_x &= 1, \end{aligned} \qquad (7)$$

$\mathrm{d}v_b$ and $\mathrm{d}v_x$ being elements of volume in Fourier and physical space, respectively.

Further, let the crystal lattice be represented by the lattice peak function z^1 and the reciprocal lattice by the lattice peak function Z^{1/v_r} (cf. Ewald[4]), such that

$$Z^{1/v_r}(b) = 1/v_r \sum_h^\infty P^1(b - b_h)$$

and $$z^1(x) = \sum_p^\infty P^1(x_a - x_p). \qquad (8)$$

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$x_p = p_1a_1 + p_2a_2 + p_3a_3$ denotes the position of the middle point of the crystal lattice cell p.

Moreover, let $\overbrace{g_1g_2}$ or $\overbrace{G_1G_2}$ denote the convolution (*Faltung*) product of two functions g_1 and g_2 in physical space or G_1 and G_2 in reciprocal space, so that

$$\overbrace{g_1g_2}(x) = \int g_1(y)\, g_2(x-y)\, dv_y \qquad (9)$$

and $$\overbrace{G_1G_2}(b) = \int G_1(c)\, G_2(b-c)\, dv_c.$$

For fixed values of x or b, the integration is to be extended over all space.

The convolution theorem of Fourier transformations states that

$$\mathcal{F}\, \overbrace{g_1g_2} = G_1G_2$$

and $$\mathcal{F}\, (g_1g_2) = \overbrace{G_1G_2} \qquad (10)$$

where $$G_1 = \mathcal{F}(g_1);\ G_2 = \mathcal{F}(g_2).$$

Now, using eq. (8), the summation (1) can be represented as a Fourier integral $\mathcal{F}^{-1}$, as follows:

$$\rho_\infty(x) = \mathcal{F}^{-1}(f'Z^{1/v_r}) = \int f'(b)\, Z^{1/v_r}(b) \exp[2\pi i(bx)]\, dv_b, \qquad (11)$$

where $f'(b)$ is any arbitrary function (requiring only to be partially smooth and free from singularities) in Fourier space, which need only to have the given values of $f(b_h)$ at points $b = b_h$, that is,

$$f'(b) = f(b_h) \text{ at points } b = b_h. \qquad (12)$$

In choosing the nature of the function $f'(b)$, one should consider the convenience of further calculation.

The convolution theorem of Fourier transformations (eq. 10) allows eq. (11) to be expressed as

$$\rho_\infty(x) = \overbrace{\rho'\, z^1} = \int \rho^1(y)\, z^1(x-y)\, dv_y, \qquad (13)$$

where

$$\rho'(x) = \mathcal{F}^{-1}(f') = \int f'(b) \exp[2\pi i(bx)]\, dv_b. \qquad (14)$$

The convolution product (13) is independent of the nature of the function $\rho'(x)$ so long as its Fourier transform $f'(b)$ fulfils eq. (12). In Fourier space this is evident from (11), since $f'(b)$ is multiplied by a lattice peak function Z^{1/v_r}, which has zero values outside $b = b_h$ (cf. Ewald[4]). In physical space, however, the correctness of (13) and (14) seems at first to be paradoxical, but can be proved as shown below.

The integral (13) can be written as

$$\overbrace{\rho'z^1} = \lim_{b\to 0} \mathcal{F}\, (\rho'(y)\, z^1(x-y)). \qquad (15)$$

Using the shift theorem of Fourier transformations, we have

$$\mathcal{F}\, (z^1(x-y)) = \int z^1(x-y) \exp[-2\pi i(by)]\, dv_y = Z^{1/v_r} \exp -2\pi i(bx).$$

Substituting ρ' and z^1 for g_1 and g_2 respectively in eq. (10), we have from (15)

$$\overbrace{\rho'z^1} = \lim_{b\to 0} \overbrace{f'\, (Z^{1/v_r} \exp - 2\pi i(bx))}. \qquad (16)$$

Since $\lim_{b\to 0} \overbrace{f'\, (P^1\, (b-b_h) \exp -2\pi i(bx))} =$

$$f'(b_h) \exp 2\pi i(b_hx), \qquad (17)$$

the identity $$\rho_\infty(x) = \overbrace{\rho'z^1} = \sum_p^\infty \rho'(x + x_p), \qquad (18)$$

with $$x_p = p_1a_1 + p_2a_2 + p_3a_3$$

(p_1, p_2, p_3 being integers) follows from (16) and (17) as soon as (12) is fulfilled.

As an example, the structure of sodium chloride at room temperature has been analysed in the following steps.

(i) A smooth curve is drawn through all the experimentally obtained values of $f(b_h)$ for $(h_1, h_2, h_3) = (200)$, (220), (420), etc., and another one through the values $f(b_h)$ of (111), (131), (133), etc.

(ii) These curves are extrapolated also for $|b| > 2/\lambda$, either after Hartree[5] or by plotting $\ln f'$ against b^2 and then extrapolating linearly.

(iii) Only in the case of reflexions having different values of $f(b_h)$ for the same $|b| = |b_h|$ is a deviation of $f'(b)$ from spherical symmetry postulated. In that case, either one can interpolate a non-spherically symmetrical curve $f'_u(b)$ or, more conveniently, one interpolates a spherically symmetrical $f'_s(b)$, and the remaining few parameters

$$\Delta_1 f'(b_h) = f'_u(b_h) - f'_s(b_h) \qquad (19)$$

are separately treated as correction terms.

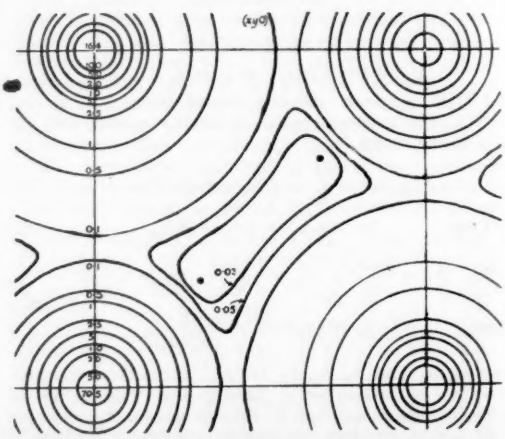
(iv) In spite of the fact that $f(b_h)$ has only one particular value for any constant value of $|b_h|$, a few values of $f|(b_h)|$ may deviate from a conveniently smooth interpolated curve $f'_g(b)$ (that is, a wavy form of $f'(b)$ in the radial direction). In this case also, one can either interpolate this wavy function $f'_w(|b|)$ or, again more conveniently, take the smooth curve $f'_g(b)$ and introduce the deviations

$$\Delta_2 f'(b_h) = f'_w(b_h) - f'_g(b_h) \qquad (20)$$

as correction terms.

The spherically symmetrical $f'_s(b)$ function, when transformed into physical space, gives spherically symmetrical density distributions ρ'_s around certain points x_a in the crystal cell, which are determined by the special structure of the crystal.

The overlapping of the spherically symmetrical distributions $\rho'_s(x - x_a)$ around such adjacent lattice



Electron density distribution of sodium chloride crystal at room temperature along (p_1p_20) plane. The remainder term $\Delta_2\rho$ of eq. (26) affects only the contour lines $\ll 0{\cdot}03$ electrons/A.^{3}

points x_a, if any, causes a deviation from spherical symmetry inside the lattice cell. Actually, such deviations were found in the case of sodium chloride (see diagram), though f'-values were spherically symmetrical.

(v) The advantage of deciding in favour of a spherically symmetrical function $f'_s(b)$ is that it can easily be transformed by one-dimensional Fourier analysis:

$$\rho'_s(r) = \frac{4\pi}{r}\int_0^\infty |b|\, f'_s(|b|) \sin 2\pi r\,|b|\, \mathrm{d}|b|\,;\quad r = |x|. \quad (21)$$

(vi) The advantage of using a smooth function $f'_g(b)$ lies in the fact that it can be resolved into a few Gaussian curves $G(b)$ the Fourier transforms of which can be calculated directly. Thus

$$f'_g(b) = \sum_{n=1}^{N} A_n\, G_n(b)$$

with

$$G_n = \pi^{3/2}\, c_r c_s c_t \exp -\pi^2\,(c_r^2 b_r^2 + c_s^2 b_s^2 + c_t^2 b_t^2) \quad (22)$$

and

$$\rho'_g(x) = \sum_{n=1}^{N} A_n\, g_n(x)$$

$$g_n(x) = \exp\,(-x_r^2/c_r^2 - x_s^2/c_s^2 - x_t^2/c_t^2), \quad (23)$$

where b_r, b_s, b_t and x_r, x_s, x_t are orthogonal components of b and x, and $c_r = c_s = c_t$ in the case of spherical symmetry.

(vii) The required electron density distribution is then given by

$$\rho_\infty(x) = \overline{\rho'_{gs}\, z^1} + \Delta\rho(x), \quad (24)$$

where the Fourier transform of ρ'_{gs} is smooth as well as spherically symmetrical, and the remainder term $\Delta\rho$ can be easily calculated, since

$$\Delta\rho(x) = \frac{1}{v_r}\sum_h^H (\Delta_1 + \Delta_2)\, f(b_h) \exp 2\pi i(bx). \quad (25)$$

In the case of sodium chloride the electron-density distribution is given by

$$\rho_\infty(x) = \left(\frac{\rho'_1 + \rho'_2}{2}\right) z''(x) + \left(\frac{\rho'_1 - \rho'_2}{2}\right) z''\left(x - \frac{a_1}{2}\right) + \Delta_2\rho, \quad (26)$$

where the Fourier transforms of ρ'_1 and ρ'_2 are smooth and spherically symmetrical, $z''(x)$ is a face-centred lattice and $z''(x - a_1/2)$ is the same lattice with its origin shifted to $a_1/2$. $\Delta_1\rho = 0$, because every $|b_h|$ has one and only one value of $f(b_h)$ and $\Delta_2\rho$ is negligible almost in the whole of the lattice cell.

The electron-density distributions calculated from equation (26) along (100), after taking into account respectively Hartree's linear extrapolation for $|b| > 2/\lambda$ (ref. 5) and the logarithmic method mentioned above, show a discrepancy which is less than 4 electrons/A.^{3} near the centres of Na^+ and Cl^- ions and negligible outside the region $r = 0{\cdot}3$ A. from the centre of each ion (the difference is less than 0·001 electrons/A.^{3}).

On the contrary, if it is taken that $f(b_h) = 0$ for all $|b| \geqslant 2/\lambda$, as is generally assumed in usual Fourier synthesis, the 'Abbruch effect' is not negligible outside $r = 0{\cdot}3$ A.; in the case of molybdenum $K\alpha$-radiation the contour lines are distorted by $\Delta\rho_{\text{Abb.}}$-waves of length $\sim 0{\cdot}4$ A. and amplitudes $\sim 0{\cdot}5$ electrons/A.^{3}, lying at the outer shells of the atoms, and $\sim 0{\cdot}1$ electrons/A.^{3} in the centre of neighbouring ions. This causes the well-known displacement of the centres.

This 'Abbruch effect' can also be calculated with the help of convolution operations. Since

$$f'(b)_{\text{Abb.}} = f' \cdot S\,;\quad \rho'_{\text{Abb.}} = \overline{\rho'\, s}, \quad (27)$$

$S(b)$, the Abbruch-shape function in Fourier space, is a sphere of radius

$$|b| = 2/\lambda = B, \quad (28)$$

and of density unity. Since

$$s(r) = \mathcal{F}^{-1}(S) = \frac{4\pi}{3} B^3.3\,\frac{\sin 2\pi Br - 2\pi Br\cos 2\pi Br}{(2\pi Br)^3}, \quad (29)$$

$\rho'(r)_{\text{Abb.}}$ shows according to (27) subsidiary maxima at distances of about $r \sim 1/B = 0{\cdot}36$ A. for molybdenum $K\alpha$-radiation. The diagram represents $\rho_\infty(x)$ along $(p_1 p_2 0)$ planes, which is obtained by using the logarithmic method of extrapolation. $\Delta_2\rho$ only causes a correction (see eq. 25) of less than 0·02 electrons/A.^{3} and affects only the region of the small island in the diagram between two adjacent chlorine ions.

The maximum possible errors in the calculated values of ρ_∞ can also be easily determined. ρ_{Na^+} and ρ'_{Cl^-} can be calculated sufficiently accurately from curves of $\ln f'/b^2$ with the help of eq. (23) and (26). They are composed of two and three $g_n(r)$, respectively.

Given the type of structure (eq. 26) and the lattice edge $|a_1| = |a_2| = |a_3| = 5{\cdot}618$ A., the whole of the sodium chloride structure at room temperature can be described by the ten following parameters only (cf. eq. 23):

	n	A_n (electrons/A.^{3})	c_n (A.)
ρ'_{Na^+}	1	13·2 ± 0·6	0·449 ± 0·006
	2	57·0 ± 3·0	0·220 ± 0·003
ρ'_{Cl^-}	1	1·8 ± 0·2	0·89 ± 0·02
	2	4·9 ± 0·8	0·46 ± 0·02
	3	157 ± 8	0·210 ± 0·002

It is very interesting to note that Na^+ with two electron shells can be described by the summation of two, and Cl^- with three, electron shells by means of three Gaussian curves $A_n g_n(r)$ (cf. eq. 23); this may not be merely an accident.

We wish to thank Prof. H. Witte and Dr. E. Wölfel (Institut für chemische und physikalische Röntgenkunde, Darmstadt) for placing their experimental data of $f(b_h)$ at our disposal (cf. Wölfel[6]). The calculations necessary to give the results shown in the table were carried out by F. Motzkus and G. Schoknecht in two days without the help of any machine, for which also our thanks are due. It is hoped to publish this work in full in the near future.

[Dec. 19.

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LETTERS TO THE EDITORS

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Quaternary Derivatives of Benzoyltropine and Benzoyl-ψ-tropine with Anticholinergic and Local Anæsthetic Properties

In the course of experiments dealing with correlations between structure and effect of cholinergic-blocking (antimuscarine, antinicotinic) actions[1,2], it has been found that in the case of compounds with tropeine structure the influence exerted on the effects by different quaternary groups shows great variations. Quaternary derivatives of tropeines possessing local anæsthetic properties, for example, benzoyltropine (= benzoyl-anti-tropine)[3], as well as benzoyl-ψ-tropine (= benzoyl-syn-tropine), have been prepared and studied[4], special consideration being given to the correlations between stereo-structure and pharmacological effect. Antimuscarine, ganglionic-blocking, curare-like, as well as local anæsthetic actions have been investigated. The effects of the individual compounds are shown in the accompanying table.

	1	2	3	4	5
Benzoyltropine HCl	0·01	< 0·1	—	1·5	
„ CH_3I	0·025	2·1	0·15	0·6	
„ C_6H_5Br	0·02	3·0	0·25	1·4	
„ n-C_7H_7Br	0·02	2·8	< 0·10	1·2	
„ n-C_4H_9Br	0·005	6·0	0·25	0·6	
„ benzyl Br	0·01	3·0	0·10	1·2	
Benzoyl-ψ-tropine HCl	0·003	< 0·1	—	2·2	2·6
„ CH_3I	0·002	< 0·2*	< 0·06	0·25	0·4
„ C_6H_5Br	0·005	6·7	0·15	0·58	2·8
„ n-C_7H_7Br	0·003	6·0	0·10	0·80	3·0
„ n-C_4H_9Br	0·005	4·6	0·25	1·50	3·2
„ i-$C_5H_{11}I$	0·003	2·8	0·20	1·55	4·3
„ benzyl Br	0·005	0·5	0·10	2·20	2·0

1. Antimuscarine effect on isolated rabbit and guinea pig intestine; atropine = 1.
2. Ganglionic blocking effect on nictitating membrane of the cat; TEA = 1.
3. Curare effect in the frog; *d*-tubocurarine = 1·0.
4. Infiltration anæsthesia on the skin of the abdomen in the rat (ref. 4); procaine = 1·0.
5. Conduction anæsthesia (frog plexus anæsthesia); procaine = 1·0.

* Ganglionic stimulating effect can also be observed.

In the case of tropeines with different stereo-structures, cholinergic-blocking effects undergo entirely different changes when quaternary groups are altered. In our opinion, when measuring anæsthetic action upon conduction, it does not suffice to use methods by means of which the motor response alone can be studied in the case of substances possessing curare activity. The derivatives we used, however, show marked activity from the point of view of infiltration anæsthetic action as well. Thus the higher alkyl, as well as aralkyl, quaternaries show activities similar to those of tertiary compounds. This effect could be observed in the case of other tropeines and other aralkyl quaternaries—for example, α-naphthylmethyl, 1-4-xylylene, as well[5]. This means that the generally accepted view, according to which local anæsthetic action of amines is confined to compounds containing secondary or tertiary amino groups, is not valid. The above view gained general acceptance most probably owing to the fact that it was mainly methyl quaternary compounds that had been studied. The methyl quaternaries have proved to be relatively inactive in the present investigations.

In our opinion, the syn- or anti-position of the OH group of tropine and the aromatic ester group bound to it[3], as well as the character of the quaternary groups, interact to influence the total stereo-structure of the compound, and thus secure the optimal molecular structure required for the different pharmacological effects[5].

Local anæsthetic action of quaternary tropeines showing anticholinergic effect suggests that the local anæsthetic action (using the term in a general sense) should be considered to be an anticholinergic effect.

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Synthesis of Quaternary Compounds possessing Lasting Local Anæsthetic Action

It has been found that, when compounds with local anæsthetic action containing tertiary nitrogen and belonging to different types of compounds are transformed into alkyl-, but especially into aralkyl-, quaternary derivatives, then the new compounds invariably exhibit a slowly developing local anæsthetic action that, however, is of very long duration. Nádor and Gyermek have found that ganglionic blocking[1] and curare-like action[2] of quaternary compounds are to a great extent dependent upon the type of chain the nitrogen is quaternarized with; therefore alkyl- and aralkyl-quaternary compounds have been used in our experiments.

Synthesis of quaternary compounds has been carried out in the following way. The tertiary compound is brought into reaction in benzene or acetone with the proper alkyl- or aralkyl-halogenide; the reaction proceeds smoothly, but care must be taken to exclude even traces of humidity. In this way, among others, diethyl-benzyl-4-(amino-benzoyl)-β-oxyethyl-ammonium bromide, that is, procaine-brombenzylate, was obtained by the reaction of *p*-amino-benzoic acid-β-diethylaminoethylester and benzyl bromide; melting point, about 120° indefinite; markedly hygroscopic. $C_{30}H_{27}O_3N_2Br$ requires C, 59·65; H, 6·68; N, 6·87; Br, 19·62 per cent; found: C, 59·32; H, 6·66; N, 6·74; Br, 19·60 per cent.

Similar methods have been used for the preparation of pantocaine-brombenzylate from methanol-ether (melting point, 168–70°), and nupercaine-brombenzylate from ethanol-ether (melting point, 183–85°).

Methyl-quaternary derivatives were prepared in the same way. The compounds dissolve readily in water and are stable. Novocaine-brombenzylate decomposes in water, a small amount of benzyl bromide being set free when exposed to prolonged standing.

Compounds have been synthesized in other ways as well, and thus evidence has been obtained that the quaternarizing alkyl or aralkyl chain was invariably added to the β-dialkyl-aminoalkyl side-chain. For example, the *p*-nitrobenzoic acid-β-bromethylester, obtained by means of esterizing glycolbromhydrine

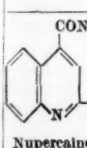
with benzoylchloride, gave with diethylbenzylamine the quaternary *p*-nitrobenzoyl ester, which, when hydrogenized in ethanol, resulted in a compound identical with the novocaine-brombenzylate already mentioned.

Further evidence of the general validity of the phenomenon is to be seen also in the fact that not only the typical local anæsthetics mentioned, but also compounds of other types as well, completely follow in their quaternary derivatives the local anæsthetics. The latter compounds, to which belong, for example, the parasympathetic blocking agents atropine and diphenylpiperidino acetamide[3], and also pyribenzamine possessing antihistaminic effect, were found to exert, in addition to the effects mentioned, also more or less marked local anæsthetic action in their tertiary forms. These compounds have been produced by the method already described.

The experiments have been extended to a variety of different alkyl, cycloalkyl and aralkyl derivatives, as well as to local anæsthetics of different types. Synthesis of these compounds is being carried out.

According to views accepted generally hitherto[4], tertiary local anæsthetics would lose their local anæsthetic effect following quaternarization. In the case of quaternary compounds the effect usually develops only after a period of about 30 min. (obviously this is the reason why these compounds have been considered to be ineffective); but in numerous cases it is 12–16 hr. before the effect develops. Methyl-quaternary derivatives are generally less effective than are corresponding tertiary compounds; but even the latter are sometimes surpassed by aralkyl derivatives.

Local anæsthetic effect as determined by means of pharmacological investigations[5] of a few characteristic compounds from among the numerous quaternary derivatives are shown in the accompanying table.

Compounds		Conduction	Infiltration
		Local anæsthetic action	
Procaine	tertiary	1	1
	methyl-quaternary	0·9	0·9
	benzyl-quaternary	2·4	6·5
Pantocaine	tertiary	6·4	8·6
	methyl-quaternary	2·8	7·5
	benzyl-quaternary	5·1	27·0
 Nupercaine	tertiary	16·0	21·4
	methyl-quaternary	3·1	14·9
	benzyl-quaternary	11·7	15·6

Details of this investigation will be published in *Acta Chimica Hungarica*. We are grateful to the Hungarian Academy of Sciences for substantial aid and to Miss Magda Markó for assistance with the experiments.

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An Olfactometer for observing the Behaviour of Small Animals

One of the earliest olfactometers was the *Y*-tube type devised by Barrows in 1907[1]. Illustrations of several modifications to this basic design of apparatus are given by Dethier[2]. A difficulty arises in the use of these designs because of the sharp line of demarcation between the odours[2] at the junction of the two arms. On reaching this point, the animal is suddenly confronted with a choice, and has little chance of rectifying a 'mistake' as it is confined to a short narrow tube, at the end of which it is trapped. The relative attractiveness of two odours is estimated by observing the numbers of animals which choose each arm of the *Y*, and there is little or no opportunity for studying other changes in behaviour initiated by the odours.

Thorpe *et al.*[4] studied the chemotropic responses of wireworms in a chamber partly filled with sand over which a stream of air was passed. A longitudinal partition reaching almost to the level of the sand divided the air in the upper part of the chamber into two sides which could each be given a characteristic smell. Although there was little mixing of the gases, the wireworms could pass freely from one side to the other, and their response was judged by counting the number which burrowed into the sand on each side. This is, in effect, a choice chamber in which only the end result is observed.

A new and very simple olfactometer has been designed which consists of a wide flat glass chamber, through which is passed a current of air. The flatness of the chamber minimizes turbulent mixing, and a known part of the air stream can be contaminated with the odour to be tested. The animal's movements and behaviour can be observed and timed as it wanders freely across a known gradient.

Six narrow strips of plate-glass were arranged to form the walls of a hexagonal chamber between two sheets of plate-glass. For the study of the behaviour of the blow-fly parasite *Mormoniella vitripennis* (Walk.) (Hymenoptera, Chalcidoidea), which is about 2·5 mm. in length, a chamber 40 cm. × 16 cm. was used (Fig. 1). The insects were introduced through one arm of a *T*-shaped entrance tube. A rate of flow of approximately 60 cm./min. was used, and smoke trails showed that the airstreams down

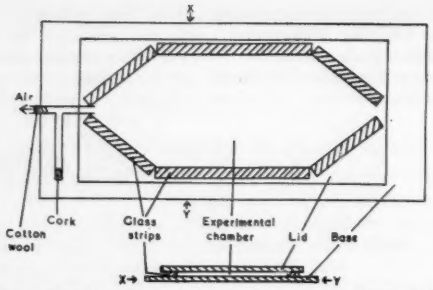

Fig. 1. Plan of the olfactometer, and a cross-section through *XY*

the broadest part of the apparatus were then parallel. The effects of diffusion were observed by drawing ammonia fumes over a smear of hydrochloric acid placed on the shaded square in Fig. 2. The limits of the area covered by the ammonium chloride are shown by the dotted line.

The odoriferous substance to be tested was placed on the shaded square and a single insect introduced through the entrance tube. The track taken by the insect was recorded on a piece of squared paper, arrow-heads being marked at 15-sec. intervals. Each experiment was continued for five minutes or until the insect walked out of the apparatus, whichever occurred first.

In the control experiments, when no odour was present, female *Mormoniella* walked straight through the apparatus. When subjected to the odour of liver on which blow-fly larvæ had been feeding, they remained in the contaminated area and followed a twisting path which frequently led them to the source of the odour. There was no evidence that the insects received a directed stimulus, apart from the tendency to walk upwind which they displayed even when no odour was present (Fig. 2). Once within the area of contamination, the insects remained there, making frequent short-radius turns, which were, however, not confined to the margins of the contaminated area (Fig. 3). Such turns were never observed on control runs, and are to be regarded as a behaviour response to the odour of the hosts' environment.

Fig. 2. Track of a *Mormoniella* female when subjected to the odour of liver on which blow-fly larvæ have fed. The dotted line shows the extent of the contaminated area; the broken line shows the track of the female during a control run, when no odour was present

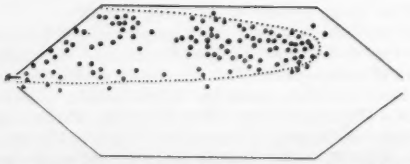

Fig. 3. Points at which *Mormoniella* females executed short-radius turns when subjected to the odour of liver on which blow-fly larvæ have fed. Dotted line shows the extent of the contaminated area. (Results from 14 experimental runs superimposed)

This type of olfactometer has the advantage of easy construction, and it can be very easily cleaned or modified. The animal's behaviour can readily be observed, and movement is less restricted than in other types of apparatus. It should be simple to modify such an apparatus for the study of aquatic animals.

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Occurrence of Vitamin E in Cod and Other Fish-liver Oils

It has been found with many different animal species that, if the diet is low in vitamin E and is supplemented with cod-liver oil, signs of vitamin E-deficiency result[1]. This observation has sometimes led to the assumption that vitamin E is not present in the oil; but the assumption has not always been confirmed by biological and chemical assays of the oil, although both methods have led to conflicting reports[2]. The following experiments were made in an attempt to clarify the situation.

Preliminary examination of three samples of cod-liver oil by the Emmerie–Engel method indicated the presence of 25·6, 30·2 and 32·2 mgm. total tocopherols in 100 gm. of the oils. Since this method is not specific for tocopherols, a fuller examination was then carried out. The unsaponifiable material, obtained from the oils by alkaline hydrolysis in the presence of pyrogallol, was freed from carotenoids, vitamin A and sterols. Chromatography of the concentrate on 'Vaseline'-coated paper, using 75 per cent ethanol or 90 per cent acetic acid as the developing solvent[3], or on silicone-impregnated paper using 70 per cent ethanol, followed by spraying with $\alpha\alpha'$-dipyridyl and ferric chloride, revealed the presence of a substance which had the same R_F value as α-tocopherol under the variety of conditions described. In addition, a mixture of α-tocopherol and the concentrate gave only one spot on the developed chromatograms.

In view of these results with cod-liver oil, and the observations by Robeson and Baxter[4] that α-tocopherol occurs in two different shark-liver oils, dogfish and Californian jewfish, five other fish-liver oils have been similarly examined. The tocopherol contents are shown in the accompanying table. For each oil, examination of the paper chromatogram revealed the presence of α-tocopherol, and no other substance reducing ferric chloride was found in the concentrates. It is probable, therefore, that α-tocopherol is a normal constituent of fish-liver oils and may act as a natural antioxidant in these oils as well as in vegetable oils.

The results for cod-liver oil confirm the observations of Dam[5] and Blaxter[6] that the typical signs of vita-

α-Tocopherol Content of Fish-liver Oils

Liver oil	α-Tocopherol (mgm./100 gm. oil)
Cod	25·6; 30·2; 32·2
Angler fish	31·9
Blue skate	25·3
Haddock	18·0
Ling	27·2
Turbot	45·0

min E-deficiency produced in animals given a ration containing the oil are not due to a deficiency of the vitamin in the diet so much as to the presence of the highly unsaturated acids of the oil.

I am grateful to Dr. J. A. Lovern, of the Torry Research Station, Aberdeen, for the samples of oils.

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Rapid Production of Malignant Hepatomas by Simultaneous Administration of Tannic Acid and 2-Acetylaminofluorene

In previous experiments we have proved the cirrhogenic[1] and carcinogenic[2] activity of tannic acid administered parenterally, and that this activity can be influenced by the protein content of the diet[3]. It seemed of interest to examine whether the simultaneous administration of another hepatic carcinogen has an influence on the carcinogenic activity of the tannic acid.

The experiment was made on fifty-six young rats of 115 gm. average body-weight divided into two groups, each group containing identical numbers of males and females. The animals of group 1 were given tannic acid solution subcutaneously once weekly (four doses of 200 mgm. per kgm. 2 per cent aqueous solution, or else 250 mgm. per kgm. 2·5 per cent aqueous solution). The diet of both groups consisted of casein 10 per cent, sunflower oil 10 per cent, cod liver oil 1 per cent, yeast 3 per cent, salt mixture 4 per cent, dextrin 22 per cent, maize grits 50 per cent. To this were added 2·5 mgm. in the first four weeks and then 3 mgm. daily per animal of acetylaminofluorene.

Of group 1 (tannic acid + acetylaminofluorene) thirteen rats died before the 160th day, of group 2 (acetylaminofluorene only) five animals died during the same period and five were killed at different times. The surviving rats were killed on the 180th day of the experiment. Primary tumours occurred only in the liver. The tumours produced could be grouped as follows: group 1, preliminary changes (that is, some changes, at most pinhead-sized nodes); group 2, explicit changes (tumours of 2–6 mm. diameter); group 3, largest growths (Table 1).

Table 1

	No. of rats	Rats with liver tumours (1)	(2)	(3)	Total	Per cent
Tannic acid and acetylaminofluorene	28	7	15	4	26	92·8
Acetylaminofluorene	28	6	2	–	8	28·5

The largest tumour produced was 5 cm. × 3·6 cm. × 3·6 cm. in size, weighing 27·45 gm.; this rat died on the 166th day of the experiment. The tumour proved histologically to be an anaplastic malignant hepatoma. Metastases were present in the regional lymph nodes.

It is well known that hepatomas due to the effect of 2-acetylaminofluorene administration[4] occur more frequently in males than in females. In this experiment, however, as a result of the simultaneous administration of tannic acid and 2-acetylaminofluorene, hepatomas developed in all the males and in twelve of the females, whereas acetylaminofluorene alone produced hepatomas in four male and four female rats.

The results for the simultaneous occurrence of hepatomas and cirrhosis are shown in Table 2.

Table 2

	Early cirrhosis	Developed cirrhosis	Total	Tumour and cirrhosis
Tannic acid and acetylaminofluorene	7	11	18	17
Acetylaminofluorene	5	—	5	1

This experiment suggests that: (1) simultaneous administration of tannic acid and 2-acetylaminofluorene greatly increases the carcinogenic activity of these substances on the liver; (2) liver cirrhosis is an important promoting factor in liver carcinogenesis.

This work will be published in detail in the *Acta Morphologica Hungarica*.

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Doubling of Chromosomes induced by Gloriosine isolated from *Gloriosa superba*, Linn.

The usefulness of colchicine as a chemical in doubling chromosomes in plants was first reported by Blakeslee[1], who obtained polyploids in *Datura stramonium* by treating its seeds with this alkaloid. Since then, colchicine has been extensively used for inducing polyploidy in many species of plants. In announcing an Indian source for colchicine, Parthasarathy[2] reported that, if fresh extract of tubers of *Gloriosa superba* is applied to maize seed before sowing, the developing roots show tetraploid sectors. This confirmed the polyploidizing influence

of the alkaloid colchicine present in these tubers, the isolation of which had been reported by Clewer, Green and Tutin[3] in 1915.

Some months ago, tubers of *G. superba* collected from the Deccan and coastal areas of Bombay State were supplied to the National Chemical Laboratory, Poona, for extracting colchicine which was required for cytogenetic and plant-breeding work in this laboratory. During the extraction, Subbaratnam[4] reported the isolation of a new alkaloid allied to colchicine which has provisionally been named 'gloriosine'. Very small quantities of the alkaloids colchicine and gloriosine extracted from *G. superba* were made available for testing their influence in inducing polyploidy. A comparison was therefore made by testing these with colchicine obtained from *Colchicum autumnale*. 0·3 per cent aqueous solutions of the three alkaloids were prepared, and plumules of germinated seedlings of two pure varieties of sann hemp (*Crotalaria juncea*) were kept immersed in the solutions for four hours and were later washed and planted out. When the plants were in flower their ploidy was determined.

Swelling and retarded growth of seedlings treated with colchicine from *C. autumnale* and gloriosine showed that polyploidy had been induced. The percentage of polyploids obtained from each of the alkaloids is given in the accompanying table.

Source of alkaloid	No. of seedlings treated	Polyploids	
		Tetraploid	Octoploid
Colchicine from *C. autumnale*	15	8	—
Colchicine from *G. superba*	15	5	1*
Gloriosine from *G. superba*	15	11	—

* The ploidy of some plants in this lot has yet to be determined.

The results of the test clearly indicate that both colchicine and gloriosine from *G. superba* have a polyploidizing effect, and that gloriosine promises to be even more effective than colchicine in inducing polyploidy. Further tests on gloriosine are in progress.

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Identification of 4-Methyl-D-glucuronic Acid in *Eucalyptus regnans* Wood

Many workers have identified the hexuronic acid components of pectins, gums and mucilages[1]. However, the uronic acid components of wood hemicelluloses have proved difficult to identify. O'Dwyer[2] and Yaramori and Tachi[3] have shown that glucuronic acid is present in the hemicelluloses of beech wood and of elm wood respectively. O'Dwyer[4,5] has obtained, from oak wood, an aldobiuronic acid containing one methoxyl group per uronic acid residue. Also, Sands and Gary[6] have obtained an aldobiuronic acid from mesquite wood hemicellulose: they demonstrated that the aldobiuronic acid contained a methoxyl group and, because of the difficulty encountered in the identification of the uronic acid (viewed in the light of the experience of Anderson and Otis[7]), suggested that the methoxyl group was attached directly to the uronic acid residue.

White[8] and Smith[9] have shown, by different methods, that the acid hydrolysate from mesquite gum (an exudate from mesquite wood) contains 4-methyl-D-glucuronic acid residues.

It has now been demonstrated that the acid hydrolysate from *Eucalyptus regnans* F. v. M. wood also contains 4-methyl-D-glucuronic acid residues. *E. regnans* shavings were hydrolysed with *N* sulphuric acid and the hydrolysate was neutralized with barium carbonate, filtered and concentrated. The barium salts (consisting chiefly of barium aldobiuronate) were isolated by repeated precipitation from aqueous ethanol, and the crude product (Ba, 16 per cent; uronic acid anhydride, 38 per cent; OCH_3, 6 per cent) was refluxed for 20 hr. with 8 per cent methanolic hydrogen chloride. The resulting crude methyl glucuronoside syrup (b.p. 132°–136° (bath temp. 185°)/0·1 mm., n_D^{28} 1·48, $[\alpha]_D^{20}$ + 88° in methanol (*c*, 2·8), 29·2 per cent OCH_3) was then treated according to Smith[9] to give the amides of 4-methyl methyl-α- and -β-D-glucuronosides. (α-form, m.p. 232°, $[\alpha]_D^{22}$ + 152° in water (*c*, 0·36): β-form, m.p. 228°, $[\alpha]_D^{21}$ − 62° in water (*c*, 0·25).) The mixed α- and β-forms, on analysis, gave: C, 43·37; H, 6·75; O, 42·8; N, 6·51; OCH_3, 27·46 per cent; $C_8H_{15}O_6N$ requires C, 43·46; H, 6·84; O, 43·40; N, 6·33; OCH_3, 28·06 per cent. Both forms of the amide gave X-ray powder diffraction diagrams the lines of which were identical with those of samples obtained through the courtesy of Dr. F. Smith.

In addition, it was shown that D-xylose (characterized as its dibenzylidene dimethyl acetal, m.p. 211° not depressed on admixture with a sample prepared from authentic D-xylose) was also present in the mother liquors resulting from the crystallization of the mixed amides and, further, that the crude barium aldobiuronate contained no glucosidic methoxyl groups. Hence it is probable that the non-resistant carbohydrate fraction of *E. regnans* wood contains residues of the aldobiuronic acid, 4-(4-methyl-D-glucuronosyl)-D-xylose.

Since this work was completed, our attention has been directed to a paper by Jones and Wise[10], who have shown that the acid hydrolysate from aspen wood contains 4-methyl-D-glucuronic acid.

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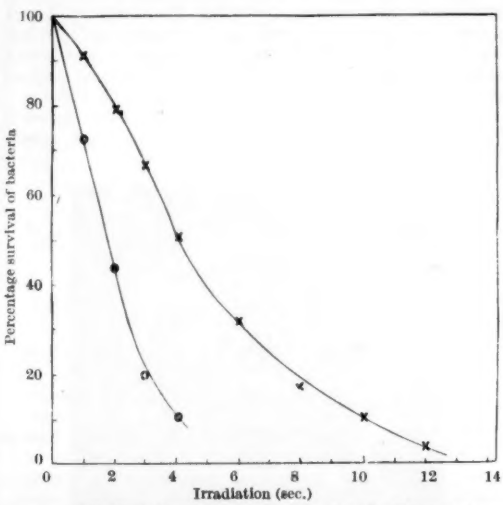
Susceptibility of Catalase-negative Bacteria to Ultra-violet Irradiation

In the tribe Lactobacteriacea there are two closely related genera—*Lactobacillus*, which are catalase-negative, and *Microbacterium*, which are catalase-positive. Representative members of these genera were selected, namely, *Lactobacillus pastorianus* (ATC 8291) as the catalase-negative bacteria and *Microbacterium flavum* (ATC 10340) as the catalase-positive bacteria. Both species form distinct colonies and have an optimum temperature near 30° C. The bacteria were reared on Difco's stock culture broth media and buffered with calcium carbonate, and incubated for seven to nine days at 30° C. *L. pastorianus* was diluted 1–10,000 and *M. flavum* 1–50,000 with physiological salt solution, and 1 ml. of the solution placed in the centre of a sterile Petri plate. The aliquot was exposed to ultra-violet radiation from a 40-watt tube, model HUVM-30 (American Sterilizer Co., Erie, Pa.), with about 90 per cent of the radiation at 2537 A. The distance from the tube to the bacteria was 43 cm. and time of exposure was at various intervals from 1 to 14 sec. Thirty plates were run for each time of irradiation, and average results are presented in the accompanying graph. Immediately after irradiation, 15–20 ml. of tomato agar was added to the plate and agitated to distribute the bacteria uniformly around the plate. The plates are incubated for seven days at 30° C. and the colonies counted. Controls were those bacteria which were not exposed to ultra-violet radiation.

The catalase-positive bacteria, *M. flavum*, is more resistant to ultra-violet radiation than the catalase-negative, *L. pastorianus*. Note in the graph that, after 4 sec. exposure to ultra-violet light, 50 per cent of *M. flavum* survive while only 10 per cent of *L. pastorianus* are viable.

Even after 1 sec. exposure there is a 20 per cent difference in survival, with *L. pastorianus* being more susceptible. These results would indicate that catalase does afford some protection from death by irradiation by decomposing the harmful peroxides which are produced, for the chief difference between the species is the presence or absence of catalase. The negative rate of change of the slope of the curve for *M. flavum* in the graph indicates that an enzymatic reaction of the second order is influencing the survival-rate.



×—×—, *Microbacterium flavum*; ○—○—, *Lactobacillus pastorianus*

Survival-rates of catalase-negative *Lactobacillus pastorianus* and the catalase-positive *Microbacterium flavum* for similar periods of irradiation

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Mitochondrial Distribution in Saccharomyces

Genetical experiments by Ephrussi and co-workers[1] have adequately demonstrated the existence of extra-chromosomal factors determining the cytochrome oxidase and succino-dehydrogenase activities of yeast clones analysed by them. A particulate nature was ascribed to these factors, and their identity with the mitochondria was suggested in view of the well-known association of the enzymes concerned with these bodies; however, no direct observations on the behaviour of the mitochondria during cell divisions were reported.

In spite of their very small size, the mitochondria of actively dividing yeast constitute the most prominently visible entities of the cytoplasm and are, moreover, not obscured by any other cytoplasmic inclusions. They are recognized by their extraordinarily uniform diameters, their ability to react with the 'Nadi' reagent and with tetrazolium, and by their staining with janus green *B*. Phase-contrast microscopy reveals them with unusual clarity in the living cell, making their behaviour and distribution in budding cells amenable to direct analysis. Table 1 indicates the frequencies of mitochondria in single haploid cells, of monosporic derivation, observed in the microscope field at random. The mitochondrial counts were made under bright contrast with Kohler method illumination and a yellow-green filter. All levels within the cell were carefully focused in succession to ensure a precise count.

The variation in frequency from 1 to 18 per haploid cell bore no relation to the differences in sizes of cells normally occurring in any actively proliferating culture. Thus, for example, small single

Table 1

No. of mitochondria per cell	No. of cells counted	Percentage of cells
1	22	3·8
2	40	6·9
3	42	7·3
4	80	13·9
5	36	6·3
6	154	26·8
7	26	4·5
8	78	13·5
9	10	1·8
10	26	4·5
11	6	1·0
12	16	2·8
13	2	0·3
14	28	4·9
15	4	0·7
16	4	0·7
17	0	0
18	2	0·3
	576	100

cells (apparently buds that separated early from the mother cell) possessed one to four mitochondria; similarly, larger single cells possessing only one mitochondrion were not uncommon. It will be noted that the number most commonly encountered is six per cell and that cells with four and eight mitochondria occur in equal frequencies, constituting half the percentage of those containing six per cell; also, that even numbers of mitochondria are more frequently encountered than odd numbers, indicating that binary divisions occur once the mitochondria enter the bud.

Direct observation of the migration of mitochondria during budding is possible with phase contrast when cells are mounted in nutrient fluid. A single mitochondrion, invariably found in the mother cell at the point of attachment of the incipient bud, enters the bud at a very early stage after performing energetic movements (usually at 10 min.). This may be followed by the entry of additional mitochondria as the bud grows, but divisions of mitochondria in the mother cell to supply the bud have not been observed though such undoubtedly occur. Fusions between mitochondria have not been observed. Table 2 indicates the distribution of mitochondria between mother cells and attached buds at various stages of bud growth. The sizes of buds relative to the mother cell are arbitrarily determined as $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and equal. Only a few representative cases among many observed are shown.

Table 2

No. of mitochondria in mother cell	No. of mitochondria in bud (or buds)	Size of bud (or buds)
6	1	$\frac{1}{4}$
14	4	$\frac{1}{4}$
6	4, 3	$\frac{1}{4}$, $\frac{1}{4}$
6	1	equal
8	1, 1	$\frac{1}{4}$, $\frac{1}{4}$
6	2	$\frac{1}{4}$
3	2	equal
4	3, 1	$\frac{1}{2}$, $\frac{1}{4}$
6	6	equal
6	1	equal
2	1	equal
10	1	equal
2	3, 1	$\frac{1}{2}$, $\frac{1}{4}$
12	3, 1	$\frac{1}{2}$, $\frac{1}{4}$
8	4, 4	$\frac{1}{2}$, $\frac{1}{2}$

It will be seen that there is no necessary correlation between the mitochondrial count and the relative size of the bud, or between that of the bud and mother cell. For example, a mother cell with six mitochondria may have only one mitochondrion, or may have six in its bud of equal size; or, a cell with ten mitochondria may have only one in its bud of equal size. These observations suggest that buds become detached at maturity or prematurely from the mother cell with inconstant, frequently low, even single mitochondrial complements, to yield the heterogeneous clones shown in Table 1.

A simple, directly observable explanation is thus provided for the origin from normal cells of occasional clones deficient in a cytoplasmic factor which is restorable on out-crossing to normal cells. It is reasonable to assume that distribution of mitochondria to the bud is random, and would not involve a preferential migration should the mother cell possess mitochondria of aberrant constitution. Indeed, instances of abnormal mitochondria have been reported in higher plants[2,3] and in yeast[4]. The present observations indicate that buds breaking away from the mother cell with only a single, 'mutant' mitochondrion, or without any 'normal' mitochondria, will be expected, as a consequence, to yield clones of 'vegetative mutants' breeding true to type such as the respiratory mutants encountered by Ephrussi. In view of the localization of a variety of enzymes in the mitochondria[5], this mechanism of the origin of vegetative mutants would explain irregularities in terminal genetical characters that are determined through the mediation of mitochondrial enzymes unless alternate pathways due directly to gene products become substituted for these deficiencies.

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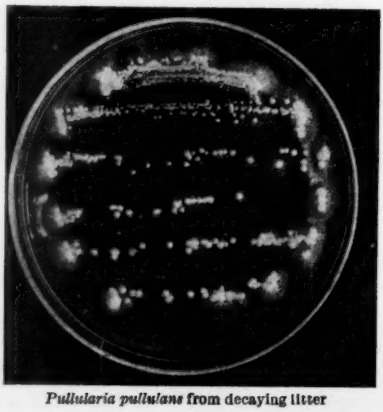
Microbiological Decomposition of Litter

The decomposition of tree litter has been the object of extensive chemical investigations; but the organisms involved in this process have attracted much less attention. Nevertheless, it appeared of interest to investigate which is the organism opening the attack on dead leaves falling from, or having fallen from, different trees in autumn.

Realizing the possibility that many kinds of organisms might be involved, we were prepared to use agar plates of different compositions; but we were surprised to find that the microflora of the leaves is much more uniform than might be anticipated. We proceeded as follows: from different trees we collected yellowed leaves, some on the point of falling, and others which had just fallen, using sterile tubes and sterile forceps. Without delay the leaves were shaken for several minutes in sterile tap water and a few loops were plated on malt agar. Using leaves of *Forsythia*, *Amelanchier*, oak, beech, apple and peach and many others, soon a very uniform growth appeared, consisting nearly exclusively of white colonies of a yeast-like organism, which proved to be *Pullularia* (*Dematium*) *pullulans* (de Bary et Löw) Berkhout[1] (see photograph). A number of strains were isolated which proved to be varieties of this organism, differing somewhat in the rate of colour production (from brown-red to black) but identical in all other respects. In leaves picked up from the soil, secondary infection is not infrequent and often bacteria and moulds are numerous.



Pullularia pullulans from decaying litter

Pullularia attacks pectin strongly, and accordingly the above suspensions of leaves were also plated on pectin agar[2]. Nearly all the pectin-splitting colonies again were those of *Pullularia*, and only a few colonies of bacteria developed. When freshly collected leaves were kept between two sterile sheets of filter paper moistened with sterile water, the number of *Pullularia* increased considerably during the first two days, and many hundreds were found where only a few were present previously; other organisms were not found to increase in numbers. Hence it appears that not only does the overwhelming majority of the micropopulation of dead leaves of many trees consist of *Pullularia pullulans*, but also that this organism is the first one to develop under conditions similar to those in newly fallen litter. This suggests that the pectin of yellowed leaves is decomposed and thus the path is cleared for other organisms to penetrate into deeper layers; but further investigation is required.

Experiments with litter in a more advanced state of decomposition showed that *Pullularia* tends to disappear and is replaced by other organisms, among which bacteria and a few moulds prevail. Investigations on this secondary flora are in progress.

Meanwhile, it occurred to us that it might be worth while to investigate the microflora of leaves at the moment of budding, and so in early spring we made the same experiments with small green leaves, just after their appearance and also at a time when they were merely green buds. Again, among the pectin-splitting organisms *Pullularia* was frequent. In a quantitative experiment, 1 gm. of fresh leaves (*Amelanchier*) was shaken with 100 ml. of water for 5 min. and 0·1 ml. was plated. Four splitting colonies were found, three being *Pullularia*, or 3,000 per gm. of leaf. When the leaves were kept between moist filter paper for three days the number had increased to 287,000 per gm. Young leaves of beech were positive for *Pullularia*; oak and fir showed only fungi, some of which were pectin-splitting varieties. But again, after a few days between moist filter paper, the number of the pectin-splitting fungi had increased so abundantly that counting in 0·001 ml. was impossible. Hence decomposition of pectin by a small number of micro-organisms appears to be of very early occurrence in the decomposition of fallen litter.

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Effect of Added Primer on Lima Bean Phosphorylase

FORMATION of an amylose-type polysaccharide from glucose-1-phosphate by the action of phosphorylase does not take place unless a small amount of starch, glycogen or dextrin is added as the priming agent. The primer, which is sometimes called activator, is required presumably because the enzyme is unable to cause the condensation of glucose-1-phosphate, but acts only by transferring glucose units from glucose-1-phosphate to the non-reducing end of an already existing polysaccharide chain[1]. There have been reported, however, two exceptions which were claimed to require no added primer in this reaction; one is purified phosphorylase of lima bean, as reported by Green and Stumpf[2], and the other is that of sweet potato, as reported by Inoue and Onodera[3]. In both cases, according to these authors, the addition of different types of primers in various amounts had little or no effect on the initial velocity of this reaction catalysed by respective enzymes. In the case of purified lima bean phosphorylase, the possibility that the enzyme preparation might be contaminated with polysaccharide was excluded, since this preparation could not serve as a source of a polyhexose catalyst for purified potato enzyme.

In an earlier study[4] of the inhibition of phosphorylase by β-amylase, such as that found in crude extracts of sweet potato, barley or wheat, it was concluded that this inhibition might be due to destruction of added primer by the action of β-amylase to give limit dextrins, which had no priming effect on phosphorylase. Addition of appropriate amounts of mercuric compounds to these extracts, so as to inhibit selectively the β-amylase activity, enables phosphorylase in these extracts to utilize the added primer, and in this way phosphorylase activity can be detected in the presence of β-amylase[5]. It was found later[6] that purified potato phosphorylase, although still contaminated with a small amount of β-amylase, actually required the added primer in the synthesis of starch from glucose-1-phosphate.

Lima bean phosphorylase was purified by the method of Green and Stumpf[2]. The purest preparation thus far obtained after eight fractionations with ammonium sulphate with frequent dialyses had a specific activity (enzyme activity in units (37°)/mgm. protein) of 0·62, thus indicating that this preparation was much inferior in purity to purified potato enzyme, the specific activity of which was usually 2·5–3·0 after four fractionations. No further purification could be attained by the use of various procedures.

Nevertheless, this preparation required an added primer in the synthesis of starch from glucose-1-phosphate, as can be seen in a typical experiment represented in Fig. 1. From this and other similar experiments, the enzyme–primer dissociation constant was calculated by the graphical method of Lineweaver and Burk[7]. The value of K_s thus obtained was 1·05 mgm. Lintner's soluble starch per 3·5 ml., or approximately 30 mgm. soluble starch per 100 ml. This is comparable with the values previously obtained for potato phosphorylase (41 mgm. Lintner's soluble starch per 100 ml.[8]; 97 mgm. Zulkowski's soluble starch per 100 ml.[9]) and for crystalline muscle phosphorylase[10] (20 mgm. glycogen per 100 ml.). The iodine colour reaction of the products of this reaction, using a small amount of dextrin (Merck; iodine colour, red) as the source of primer, changed from red-purple via purple to deep blue, indicating the formation of an amylose-type polysaccharide.

The purest enzyme preparation used in the above experiment still contained a trace of primer polysaccharide, as can be seen in a typical experiment represented in Fig. 2. Treatment of the boiled lima bean enzyme with purified sweet potato β-amylase was effective in removing the contaminating primer, which is a further proof of its polysaccharide nature. The exact amount contained in the purified lima bean preparation was not determined, but a simple calculation shows that the amount is far less than 2 mgm. soluble starch per ml. enzyme preparation, which is enough to give a half-maximal activity to the potato enzyme in the experiment of Fig. 2. This amount

of polysaccharide, which corresponds to 0·05 mgm. soluble starch contaminated in the lima bean enzyme used in the experiment of Fig. 1, will give an error of approximately 5 per cent in the determination of the *Ks* value; an error of this order is permissible in experiments of this nature.

Although I cannot account for the results obtained by Green and Stumpf, it can now be said that, without exception, phosphorylase requires an already existing polysaccharide primer in the synthesis of starch from glucose-1-phosphate.

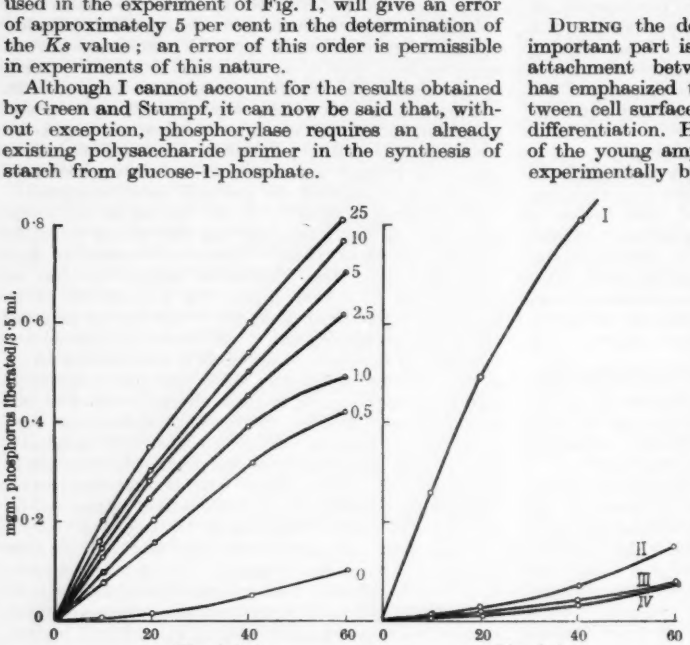

Fig. 1

Fig. 2

Fig. 1. Effect of added primer on purified lima bean phosphorylase in the synthesis of starch from glucose-1-phosphate. The reaction mixture contained 1 ml. 0·5 *M* acetate buffer (*p*H 6·0), 0·5 ml. purified lima bean phosphorylase (prep. *LB.E8*; 1/20 diluted), 1 ml. 0·1 *M* glucose-1-phosphate, and various amounts of Lintner's soluble starch as indicated on the curves. Total volume, 3·5 ml. Incubation temperature, 37 ± 0·1°. At intervals, samples were withdrawn from the digests, deproteinized with 5 per cent perchloric acid, and tested for inorganic phosphorus

Fig. 2. Effect of primer polysaccharide in purified lima bean phosphorylase. The standard digest (curve IV) contained 1 ml. 0·5 *M* acetate buffer (*p*H 6·0), purified potato phosphorylase, and 1 ml. 0·1 *M* glucose-1-phosphate. Other digests contained in addition: curve I, 25 mgm. Lintner's soluble starch; curve II, 0·5 ml. boiled lima bean enzyme (prep. *LB.E8*); curve III, 0·5 ml. boiled lima bean enzyme, treated with purified sweet potato *β*-amylase, and heat-inactivated. Total volume of each digest: 3·5 ml. Incubation temperature: 37 ± 0·1°. At intervals samples were withdrawn, deproteinized with 5 per cent perchloric acid, and tested for inorganic phosphorus

The lima bean used in this study was a commercial product (Baby lima beans from Chester B. Brown Co., Morrill, Nebr., U.S.A.), made available by the courtesy of Messrs. S. Wada and N. Yamada, to whom I wish to express my thanks.

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Experimental Dissociation of Cells from Chick Embryos

During the development of an embryo, a very important part is probably played by the forces of attachment between cells. Weiss[1] in particular has emphasized the importance of interactions between cell surfaces in the processes leading to tissue differentiation. Holtfreter[2,3] has shown that the cells of the young amphibian embryo can be dissociated experimentally by alkali-treatment, and Mookerjee *et al.*[4] has made a comparative study of the firmness of cell-attachment both in different species of Urodele and during the course of differentiation of one particular organ, the notochord. A similar type of cell-dissociation has now been shown to occur in the chick embryo.

Whole embryos, or parts of them, at the primitive streak stage, are placed in chick Ringer solution the *p*H of which had been brought to 9–9·2. Within a few minutes the cells fall apart either singly or in small groups. The cells are at first rounded, but may later become elongated or flattened, with irregular outlines. An intake of water clearly occurs, and an ectoplasmic layer may be lifted off from the endoplasmic interior. The ectoplasm may assume the form of a lobular pseudopodium, which can appear at any point on the cell surface. With increasing imbibition of water the ectoplasm may be lifted away from the endoplasm over the whole surface of the cell. Churning movements are visible within the endoplasm. Over-exposure to alkaline media renders the cell surface so permeable that large visible particles may leak out through the membrane, which eventually may take on a crenated appearance shortly before the death and complete disintegration of the cell. Except in the final stages, these cell changes are quickly reversible by alteration of the *p*H to the acid side. The general picture is thus extremely similar to that seen in the tissues of early amphibian embryos.

After the experiments reported here were concluded, Moscona and Moscona[5] have published observations on the dissociation of tissues of later stages of the chick embryo.

The work described here was carried out while I held an I.C.I. Research Fellowship of the National Institute of Sciences, India. Thanks are due to Dr. Subodh Mittra, director of the Chittaranjan Cancer Hospital, for the provision of laboratory facilities.

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Rapid Specific Preventive Action of Tetanus Toxoid

KRECH[1] has found that mice infected with tetanus spores could be saved by toxoid alone, an antitoxin not being used, whereas the control animals died. He also gave toxoid in two doses 24 and 48 hr. before a lethal dose of toxin. The eight mice injected with toxoid survived while the two control animals died on the sixth and ninth day respectively. He concluded that these effects were due to the rapid formation of antibodies. Lemétayer[2], also using toxoid, was able to produce a retardation of the onset of the signs of tetanus if he gave it one day before the toxin.

Raynaud *et al.*[3], using larger doses of toxoid, given one day before, were able to prevent all signs and lethal effect of 1 minimum lethal dose (m.l.d.) of toxin. These results were obtained by subcutaneous injections into the hind limbs, and there was the possibility that these effects could be either local or non-specific. Again, the effect may only have been produced if the toxin and toxoid were made from a filtrate produced by one strain of organism.

In the experiment described below, an attempt was made to overcome these objections. The toxoid was given intravenously, a toxoid from another laboratory was used, and an extra control group of mice was given diphtheria toxoid.

Table 1. MICE WERE GIVEN 1 M.L.D. OF TETANUS TOXIN SUBCUTANEOUSLY. SOME HAD RECEIVED VARIOUS TOXOIDS INTRAVENOUSLY 24 HR. EARLIER

Type and dose of toxoid	No. of mice used	No. of animals dying of tetanus in less than 6 days	Remarks
Tetanus (Copenhagen) 500 Lf	6	0	None died or showed local tetanus*
Diphtheria (Copenhagen)	6	6	All showed local tetanus on second day after toxin
Tetanus (Pasteur) 700 Lf	6	0	None died or showed local tetanus*
Nil	6	6	All showed local tetanus on second day after toxin

* Observed for 20 days.

The results in Table 1 show that tetanus toxoid given intravenously completely prevents the onset of local tetanus and death from 1 m.l.d. of toxin given subcutaneously 24 hr. later. The amount of toxoid used was very large when compared with the amount of toxin, for as 1 Lf of toxin is approximately equivalent to 10,000 mouse m.l.d. of toxin, the toxoid/toxin ratio in these experiments is approximately 5×10^6 to 7×10^6.

In another experiment it was found that 200 Lf of toxoid gave complete protection against 1 m.l.d. of toxin but not against 4 m.l.d. Using this smaller dose of toxoid, 1 m.l.d. of toxin was given to groups of mice at increasing intervals after the toxoid (see Table 2). These results show that the protection lasts only a short time, for even when the toxin was given two days after the toxoid few animals survived. When the interval was six days no protection was found.

Krech's suggestion that this phenomenon is due to rapid formation of antibody appears to be untrue, as no antibodies have been detected during the first days after administration of toxoid (unpublished work). The most probable explanation of the action of toxoid would appear to be either a prior blocking of the hypothetical receptor substance in the central nervous system, similar to an interference phenomenon, or a competitive inhibition of the action of the toxin.

Table 2. TETANUS TOXOID (200 Lf) WAS INJECTED INTRAVENOUSLY INTO MICE AND 1 M.L.D. OF TOXIN WAS GIVEN SUBCUTANEOUSLY 1–6 DAYS LATER

Intervals between giving toxoid and toxin (days)	No. of animals in each group	Number of animals surviving at various times after the injection of toxin (days)			
		4th	8th	12th	16th
1	6	6	6	6	6
2	6	6	4	2	1
3	6	6	4	2	2
4	6	6	3	2	1
5	6	4	3	2	1
6	6	3	2	1	0

The phenomenon is being investigated to determine which of the two probable explanations is correct, and also to find out if other toxoids can protect animals from their analogous toxins.

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Isotope Curves in Red Blood Cell Studies

WHEN iron-55 or a carbon-14—or nitrogen-15—labelled substrate is fed to an individual, a portion of the isotope is incorporated in red cell hæmoglobin[1–4]. Curves of subsequent changes in the amount of isotopic excess can be explained and used for calculating the survival curve of red cells, as well as their average time of utilizing the incorporated substance.

A schematic curve is shown in Fig. 1 over a time scale marked at about 30-day intervals. The tagging during the first month reflects mitosis and maturation in the bone marrow, while the plateau of the second month shows completion of the isotopic uptake. Mollison[5] and Rimington[6] gave qualitative descriptions of the reutilization represented by the singly hatched area of Fig. 1.

To get the average cell life L, the reutilization fraction r, and the average material utilization time T, consider Fig. 1 with total hatched area A, cross-hatched area A', and B and H as shown. A convenient method of determining these areas consists of plotting them on paper of known and uniform mass per unit area, cutting out and weighing the outlined areas, and calculating them from their masses. Then $T = A/H \fallingdotseq A'/(H-B)$ and $L \fallingdotseq A'/H$ and

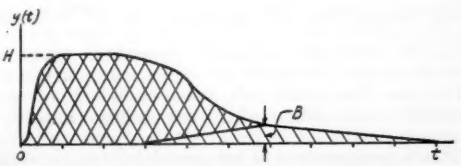

Fig. 1. Schematic curve of isotopic tagging of red-cell hæm

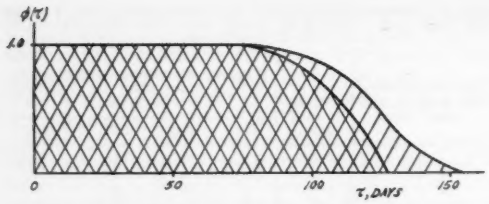

Fig. 2. Approximate survival curve of animal red cells (ref. 1) including designation of the wearing fraction

$r = l - L/T \doteqdot B/H$. In normal cases[1-3,7], L is 100–130 days, T is between 125 and 145 days for nitrogen and carbon and between 390 and 580 days for iron, while r is 0·1–0·25 for nitrogen and carbon and 0·65–0·8 for iron.

To determine the fraction of red cells surviving to each age of τ days, or $\varphi = \varphi(\tau)$, let $y_c = y_c(t)$ represent the height of the cross-hatched area above time t. With this correction for reutilization, apply equation (16) of ref. 1 in the form

$$\varphi(\tau) = y_c(\tau+\tau_0)/H - \frac{dy_c(\tau+\tau_0)}{d\tau}\Big/bH,$$

which allows a correction of a couple of days, τ_0, for averaging out any prolongation of the feeding time and for deducting the initial lag of about a day in the release of tagged cells—the b of this equation is the fraction (empirical) of previously unreleased tagging that is released each day. To obtain further detail in the description of red cell survival, consider the two sequential stages in the lives of circulating red cells[8]. These are (i) a period of wearing and (ii) a subsequent random breakdown of worn cells. Evidence of these two stages is found in Ashby curves discussed in an earlier communication[8]. If k is the rate of random breakdown, or $\max_{\tau}\left(\frac{d\varphi(\tau)}{d\tau}\Big/\varphi(\tau)\right)$, and if $\varphi_1(\tau)$ is the fraction of cells still undergoing wearing at time τ, then $\varphi_1 = \varphi_1(\tau) = \varphi(\tau) - \frac{d\varphi(\tau)}{d\tau}\Big/k$. The result of applying the equations for φ and φ_1 to a normal case[1] is shown in Fig. 2, in which φ covers the total hatched area and φ_1 covers the cross-hatched area. Because of the reutilization correction, these results are an improvement on those of Shemin and Rittenberg[1], while the addition of φ_1 is a motivated extension.

The φ used here is the same as that of Callender, Powell and Witts[9], but its determination is more direct in the isotope studies than in the Ashby studies. The case of Fig. 2 shows a wider spread in the times of declining φ than do their Ashby cases.

The proper value of L is given by $L = \int_0^\infty \varphi(\tau)d\tau$, and this agrees with the above expressions for L. These estimates of L are more accurate than the earlier assumption of symmetry of $\frac{d\varphi(\tau)}{d\tau}$ about $\tau = L$ [1,7]—although the latter procedure tends to compensate for the lack of the reutilization correction.

Diseases like sickle cell anæmia[7], which involve relatively short values of L, are still incompletely analysed.

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Red-Cell Survival and Ashby Curves

Callender, Powell and Witts[1] gave an expression for the determination of the fraction of red cells surviving to age τ, or $\varphi = \varphi(\tau)$, from the Ashby curve[2] of $Y = Y(t)$, which is the number of transfused red cells surviving in the recipient at time t. Their equation is, with average red-cell life $L = \int_0^\infty \varphi(\tau)d\tau$, $\varphi(\tau) = -L\frac{dY(\tau)}{d\tau}\Big/Y_0$, where Y_0 is the number of red cells transfused (these are assumed to be a representative steady-state population). The importance of this result has not previously been fully realized.

The application of the above expression for φ should be extended considerably when it has been supplemented with a good method of determining the scale factor L/Y_0. The determination of L in this factor appears to require previous knowledge of φ.

However, $\varphi(0) = 1{\cdot}0$, so that $L/Y_0 = -1\Big/\frac{dY(0)}{dt}$, and thus the difficulty can be solved by getting a good value for the initial Ashby slope, $dY(0)/dt$, at least whenever the curve is not complicated by donor-recipient differences. In the latter cases $dY(0)/dt$ can be determined by extrapolation from later times on a preliminary plot. Ashby curves showing rapid cell destruction are essentially exponential, whereas those showing the slower normal destruction are roughly linear, so the preliminary plots of $dY(t)/dt$ should be made on semilog and linear paper, respectively, for those two types of Y curves. With this judiciously chosen (possibly extrapolated) value of $dY(0)/dt$, the final result is

$$\varphi(\tau) = -\frac{dY(\tau)}{d\tau}\Big/\frac{dY(0)}{d\tau}.$$

According to the motivated interpretation of Ashby curves[3], the circulating red cells undergo two successive stages in their life-history: (i) a period of wearing the duration of which depends on the donor, except

in recipients having acquired anæmia, and (ii) a period of subjection to a first-order random breakdown at a rate that depends on the surrounding environment and which can therefore differ between donor and recipient. This interpretation agrees with Callender, Powell and Witts's result, and it further shows that if $\int_0^\infty \varphi(\tau)d\tau$ is calculated from the φ observed in the recipient, it will give the L for the donor (except with recipients having acquired anæmia) because of a compensation between the effects of donor-recipient differences at the two ends of the observed curve.

Fig. 1 illustrates the result of applying this treatment to a curve of normal cells in a recipient with idiopathic hypochromic anæmia[4]. For this case L is about 85 days. It shows a greater spread in the times of declining φ than do the curves of Callender, Powell and Witts[1]. In that regard it resembles more closely the normal survival curve determined by the more direct and therefore more accurate method of isotopic tagging[5,6].

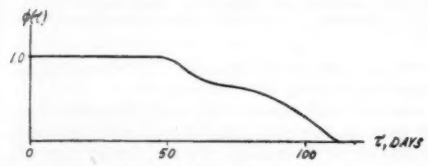

Fig. 1. Approximate survival curve of normal cells in a recipient with idiopathic hypochromic anæmia (ref. 4)

However, the results of isotopic tagging in cases like sickle cell anæmia, which involve short values of L, are not yet fully explained[7]. On the other hand, Fig. 2 shows φ for sickle cell anæmia as calculated by the above method from an Ashby curve of Callender, Nickel, Moore and Powell[8]. For this case L is about six or seven days. The φ curve is evidence of wide gradation between a large fraction of cells that die rapidly and a much smaller fraction with much longer survival times. In particular, the original Ashby curve is represented approximately by the equation $Y(t) = 0{\cdot}35\,(\exp -0{\cdot}25t) + 0{\cdot}29\,(\exp -0{\cdot}035t)$, so that empirically about $0{\cdot}35 \times 0{\cdot}25/(0{\cdot}35 \times 0{\cdot}25 + 0{\cdot}29 \times 0{\cdot}035)$, or 0·9 of the cells may have an average life of about 1/0·25 or four days, while the rest may have an average life of about 1/0·035 or thirty days. This result should aid the eventual elucidation of such cases.

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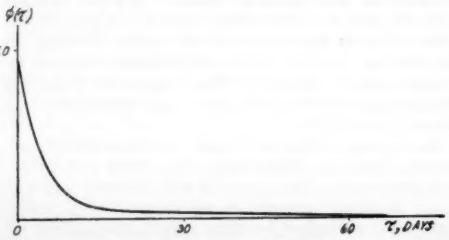

Fig. 2. Approximate survival curve of cells from a donor having sickle cell anæmia (ref. 8)

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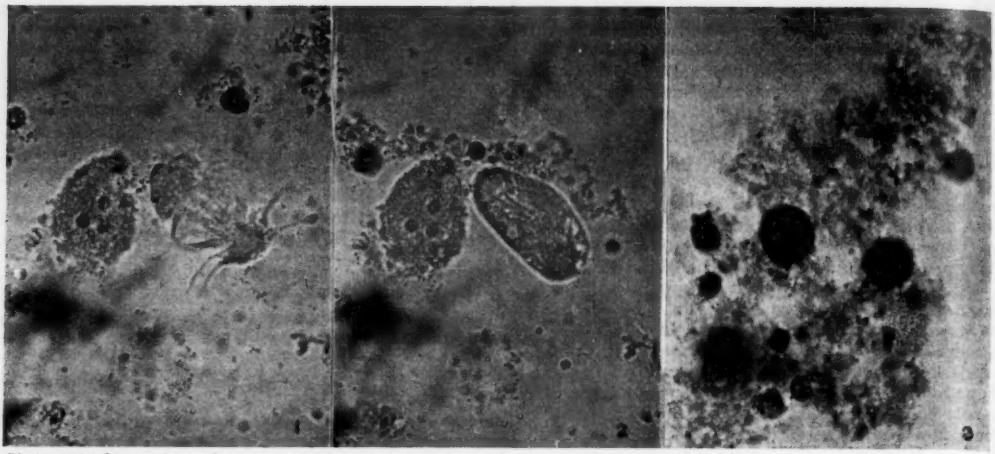
Dividing Nuclei in Coconut Milk

Cutter, Dubé and Wilson[1] have published some interesting information regarding the growth and development of the coconut fruit. Apart from physiological studies on the growth and development of the endosperm tissue, they have detected the presence of free nuclei suspended in the milk, and by slowly centrifuging the milk they have successfully isolated such nuclei in the living state. The present observations have resulted from an attempt to follow up that work to see whether the fruit with its exposed nuclei can be used as a living receptacle for testing the direct effect of antibiotics and other substances on chromosomes. Hitherto, such studies have been confined to onion root tips, which can be made to grow in water.

Coconuts of graded size were collected from the experimental station of the Bose Institute and stored in the cold room (25° ± 2° C.) for a week. Fruit were cut open every day to observe (1) in which stage the free nuclei appeared, (2) whether growth of tissue took place by somatic divisions, and (3) whether division could continue in fruit after they had been picked from the tree. The solid or semi-solid endosperm and drops of the liquid milk were fixed in acetic alcohol and aceto-carmine, or Feulgen squashes were afterwards prepared. As observed by Cutter *et al.*, the tissue is at first a syncitium but later becomes walled. It will be seen from the accompanying photographs that the nuclei are of different sizes, in the present instance varying in diameter from 16·6 μ to 72·2 μ. The meristem of the endosperm creeps along the inner face of the endocarp, starting from the micropylar end towards the other side and covering the walls completely as it progresses. The endosperm grows also in thickness; but due to the large size of the embryo sac, the inner cavity is never completely filled up, and there is a little water containing free nuclei right up to the end of development in the mature fruit. This type of embryo sac is unknown in other families and cannot be classified under any of the types of Maheshwari[2] or Johansen[3].

A drop of milk mounted without fixation or staining may be seen to carry many of these free nuclei, some of which may even be in the dividing state, with large spindle, chromosomes and perhaps an



Photographs from a drop of water mounted straight from the fruit. (1) Two free nuclei, one in resting condition and the other at late telophase. There are fragments of cytoplasm and some bacteria in the field. All are suspended in the water or 'milk'. (2) The same two nuclei photographed 10 min. later. The one at telophase has reverted to one nucleus, conditions being unfavourable for the progress of division. (3) Nuclei of various sizes embedded in a floating mass of cytoplasm. Nuclei have taken up the vital dye, acridine orange. × 3,500

adhering film of cytoplasm. Chromosomes may be visible under high power (× 400) only. Regular somatic division figures, however, have been seen in free nuclei adhering to the tissue, in those inside the syncitium and in those in the walled tissue. Chromosome counts have been obtained from stained material. They vary from 32(2*n*), 48(3*n*) to 160(10*n*). The meristematic syncitium of the fruit may show abundant division figures after being stored in the cold room for as long a period as eight days, but not if kept in the refrigerator for even six hours. At the latter temperature (5° C.), nuclei pass into the 'resting' stage.

Cutter, Dubé and Wilson were not able to detect any division figures in the endosperm and concluded that the tissue perhaps divides 'amitotically'. Present observations do not support this view. These authors also mention that free nuclei are found in the milk before endosperm development begins, and they think that development of the endosperm is initiated by deposition of these nuclei on the walls of the embryo sac. My observations, however, show that the free nuclei do not appear in the water until a little of the endosperm, if only the barest film, has begun to form. It appears more likely that these free nuclei become detached from the loose jelly of the syncitium and become suspended in the water. Otherwise, their origin is difficult to visualize.

Further cytological and experimental work is being carried out with this very promising material, which yields such large numbers of chromosomes almost directly exposed in the water, unbounded by cytoplasm or cell wall. Preliminary observations have been made on the fruit of the betel nut (*Areca catechu*, Linn.), which resembles the coconut fruit in appearance and development, starting with the large embryo sac cavity filled with water, although about a twentieth the size of the coconut fruit. In this case the little cavity, containing not more than 2 c.c. of water, finally becomes completely filled by growth of the endosperm, and the edible nut is actually formed of the hardened endosperm. In a drop of the water mounted under the microscope, the same type of free nuclei can be seen, some of them dividing, with the large spindle figure and chromosomes discernible under high power. The chromosomes are smaller than those of the coconut.

Coconuts and allied fruits are therefore not only good sources for obtaining measurable quantities of free nuclei, as found by Cutter, Dubé and Wilson, but may also be observed for chromosomes as well. They are easily accessible, yield a great deal of material and may be stored for days without deterioration.

Thanks are due to Dr. D. M. Bose, director of the Bose Institute, for his encouragement in the work, and to Sri K. L. Chaudhuri of the Institute for the photomicrographs.

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Occurrence of *Verticillium* in Potato Tubers in India

Verticillium wilt of vascular plants has been reported from various countries. In India it has been recorded by Patel, Qureshi and Bhide on egg plants (*Solanum melongena*)[1]. Though very common in potatoes, it has not been noticed in India until now.

In September 1952, while collecting potato tubers from different cultivated crops in the Bhowali–Naini Tal area, we came across several diseased tubers, one of which yielded species of *Fusarium* and *Verticillium*. This species of *Verticillium* closely resembles *V. albo-atrum* R. and B.

On potato dextrose agar its characters are as follows: conidia ellipsoidal, unicellular 4–8 × 1·5–3 μ; primary whorl of branches, 2–7 in number and 32–48 μ apart, bearing secondary branches; conidiophores, 120–230 μ in length. The terminal branch of the conidiophore is 16–24 μ in length. Conidia are sometimes collected in heads on the sterigmata tips.

This is the first report of *Verticillium* attacking potatoes in India. Presumably it causes considerable damage to potato crops here. Further work on the morphology, cultural characters and pathogenicity is being studied in detail.

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A Cinematographic Technique, using Ultra-violet Illumination, for Amphibian Blood Circulation

Ever since Marey[1] used cinematographic techniques in 1892 for recording the circulation in a tortoise's heart, many biologists have found the ciné camera a useful instrument for the registration of cardiac movements. Many details of amphibian circulation are, however, not yet fully agreed upon, and in a series of recent papers, Foxon[2] revived the controversy about the selective or non-selective distribution of the oxygenated and de-oxygenated blood to the arterial arches in the heart of the frog, *Rana temporaria*. While Foxon claimed to have established a non-selective distribution by means of direct X-ray cinematography, the present work shows that, in *Hyla cærulea* at least, the blood is sometimes distributed in the manner postulated by the classical theory of Brucke and Sabatier; that is, the streams of deoxygenated and oxygenated blood are kept distinct and distributed selectively to the arterial arches.

Direct X-ray cinematography has always suffered from the necessity of moving comparatively large masses of sensitive material and of using lead-shutters, and has thereby restricted the frequency and total duration of exposure. Foxon was able to obtain only fifteen pictures for each experiment at 3 frames per sec. recording two to three cardiac cycles during the 5 sec. of his total exposure. The present technique consisted in the direct recording, at 16 frames per sec., of the exposed amphibian heart on colour film, using a source of illumination rich in the ultra-violet region of the spectrum and showing up blood circulation by the injection of fluorescein.

After opening the abdominal cavity of an anæsthetized frog, *Hyla cærulea*, about 1 c.c. of frog–Ringer solution containing 0·005 gm. of fluorescein per ml. was injected slowly into either the anterior abdominal or the left jugular vein. The source of illumination was a 500-W. d.c. high-pressure mercury vapour lamp, and in order to eliminate most of the visible light, a Corning filter, No. 5113, having a transmission of 45 per cent at 4050 A., was interposed. Similarly, to absorb any reflected ultra-violet radiation, a Corning filter, No. 3421, was placed between the amphibian heart and the lens of the ciné camera. A Ciné Kodak Special I, with a 63-mm. lens, *f* 2·7, and 50-mm. extension tube, was used and records of considerable contrast resulted. Due to the heavy absorption of the filter No. 5113, the colour balance of the Kodachrome, type *A*, was materially upset and produced bright yellow blood-vessels on an under-exposed blue background, a highly desirable and not unpleasing effect. Evaluation of the films was carried out by preliminary loop-projection and later by detailed frame analysis.

Apart from immediate visual inspections on thirty other frogs by one of us (J. R. S.), a total of eight cinematographic records were made with the above technique, six of which showed a non-selective distribution of the blood and two a highly selective distribution in which the dyed venous blood passing out from the ventricle was sent to the pulmo-cutaneous and systemic arches but not to the carotid arch. In one of these two films the dye is seen clearly entering the pulmo-cutaneous arch before it appears in the systemic arch. This type of distribution conforms so closely to that postulated by the classical theory that we consider Foxon's categorical statement: "the classical hypothesis is, quite frankly, wrong" to be untenable as a general statement, and that in certain circumstances the blood is distributed as Brucke and Sabatier have postulated.

Further work is proceeding in order to determine what the exact circumstances are which bring about this selective distribution; but in the meantime it is hoped that the cinematographic technique, described above, might prove useful to other workers in this and other biological investigations.

J. R. Simons

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A. R. Michaelis

Sirius Avenue,
Mosman, N.S.W.
Jan. 29.

[1] Marey, E. J., "Le mouvement du cœur, étudie par la chronophotographie", Monit. photogr. 1892, p. 162 (*Le Mouvement*, Masson, Paris, 1894; Heinemann, London, 1895).
[2] Foxon, G. E. H., *Proc. Zool. Soc. London*, **121**, 529 (1951).

The method described by Simons and Michaelis for the study of the amphibian circulation seems to promise to be useful, and full results should be most interesting.

Before, however, I can begin comparing the results of Simons and Michaelis on *Hyla cærulea* with my own and those of other workers who have used *Rana temporaria* and *Bufo bufo*, it seems desirable that we should agree as to what precisely the term 'classical hypothesis' denotes. My own view has been that it is a hypothesis concerning the mode of action of the anuran heart which accounts for a selective distribution of the blood from the two auricles (I do not call it 'oxygenated' and 'deoxygenated' blood, for in *Rana* there is no evidence that the degree of oxygenation of the blood in the two auricles is constantly different). The real basis of the 'classical hypothesis' is differences in pressure in various vessels, which cause the blood leaving the ventricle during different phases of systole to be directed in various ways, causing differences in the time of movement of the blood in the principal arteries. Also, blood is supposed to flow at one time up one side of the spiral valve of the conus and another time up the other side. Vandervael[1] stated that these time differences were not to be seen in frogs in which the heart and arteries were viewed by trans-illumination. I confirmed[2] his results using similar methods; thus the evidence that the heart of the frog *Rana temporaria* does not function in the manner of the classical hypothesis has nothing to do with injection studies of any kind. The classical hypothesis of the mode of action of the heart is, I believe, not

correct. This, however, as I[2] pointed out, does not preclude a selective mechanism of distribution of blood brought about by the anatomical arrangements of the heart. Vandervael[1], by the injection of indian ink in *Rana*, concluded that mixing of the blood from the two auricles was complete, and I[2] have said that the mixing of the indian ink was considerable; Savolin[3], working on *Bufo bufo*, also found that mixing was considerable, although there might be some selection whereby the carotid arteries received slightly less of the blood from the right auricle than did the systemic and pulmo-cutaneous arches.

The radiographic studies referred to by Simons and Michaelis have been undertaken mainly as an illustration of the results achieved by indian ink injections. It was hoped that perhaps the densities of the shadows might have allowed of some evaluation of the degree of mixing taking place, but this has not been possible. I have never claimed to have demonstrated complete mixing; however, I believe mixing to be considerable.

I believe that in Anura we see a group of animals which have become greatly modified in many respects, not least in regard to skin respiration. In correlation with skin respiration we see also a highly modified heart, for I think it likely that in early Amphibia the division of the heart into two sides was more complete than in modern members of the group. If this is so, we are seeing a loss of division in the heart, and, in fact, it is well known that more aquatic amphibians show great reduction of the spiral valve and fenestration of the inter-auricular septum (see Noble[4]). It is therefore to be expected that certain Anura have a more selective circulation than others, and it is probable that *Hyla cærulea* is one of these. What is new is the suggestion that this selective circulation can be switched on or off according to circumstances. I shall await further reports with interest, particularly those of the actual mechanism by which selection is accomplished.

G. E. H. Foxon

Department of Biology,
Guy's Hospital Medical School,
London, S.E.1.

[1] *Arch. Biol. Paris*, **44**, 577 (1933).
[2] *Proc. Zool. Soc. Lond.*, **116**, 565 (1947).
[3] *Comment biol., Helsin.*, **10**, No. 4, 1 (1948).
[4] *J. Morph.*, **40**, 341 (1925).

Pharmacology of the Alkaloids of *Aspidosperma oblongum* A.DC.

A preliminary pharmacological investigation of the total alkaloids of *Aspidosperma oblongum* A.DC. obtained by classical methods has been carried out. A 6 per cent solution of the hydrochlorides in an appropriate isotonic saline at *p*H 6·8 was used.

The solution caused relaxation and loss of tone when applied to the isolated ileum of the rabbit and rat. Peristalsis was inhibited in proportion to the dose given. The characteristic actions of acetyl-choline and barium chloride were antagonized. The antagonism to acetyl-choline bore a linear relationship to the dose given. The characteristic effects of histamine and acetyl-choline on the guinea pig ileum were antagonized, the antagonism bearing a linear relationship to the dose given.

The normal movements of the isolated uterus of the rabbit, guinea pig and rat were inhibited and the actions of acetyl-choline and barium chloride strongly antagonized.

Antagonism to the action of adrenaline on smooth muscle was demonstrated on the isolated rabbit uterus.

In the frog rectus abdominis muscle preparation, a linear relationship between dose of the alkaloids and extent of inhibition of the action of acetyl-choline was demonstrated. About one-tenth of the activity of curarine chloride was shown in this respect.

In the frog gastrocnemius sciatic nerve preparation, a curare-like neuro-muscular blocking action reversible by physostigmine was demonstrated.

When tested by Sollmann's frog plexus anæsthesia method[1] as modified by Bulbring and Wajda[2], a graded local anæsthetic action was shown.

In the isolated and *in situ* frog-heart preparations the rate and amplitude of the contractions were reduced by a small dose (0·06 mgm.). A larger dose (0·6 mgm.) caused irreversible stoppage. Prior atropinization did not modify these effects. Electrical stimulation of the vagus in the latter preparation did not produce its characteristic effects.

In Langendorff heart preparations of the cat, rabbit, guinea pig and rat, the alkaloids caused a reduction in rate and amplitude followed by a well-marked auriculo-ventricular block, unmodified by previous atropinization. The block was reversible.

In the rabbit and the rat electrocardiogram, doses which caused marked slowing of the heart were seen considerably to reduce the amplitude of the *P* wave, to invert the *QRS* wave and to prolong and increase the amplitude of the *T* wave. The *PT* interval was almost doubled.

Intravenous administration of small doses to nembutal-anæsthetized rabbits and cats lowered the blood pressure and slowed the heart.

Doses of 6–30 mgm. were injected into the ventral lymph sacs of frogs. Complete paralysis was exhibited within a few minutes. The higher dose caused death within thirty minutes; at lower dose-levels there was occasional recovery.

In mice and rats parenteral administration of sub-lethal doses of the alkaloids caused the animals to become quiet and their movements sluggish. The eyelids were closed and there was an appearance of drowsiness. The limbs were extended, the heart slow and irregular. Complete recovery took about two hours. Lethal doses caused slowing and irregularity of the heart followed by violent clonic convulsions. Convulsive episodes alternated with periods of exhaustion. Death was due to heart failure.

Our investigations point to the presence of a potent cardioactive substance which antagonizes acetyl-choline or is associated with substances having this property. Studies on the chemistry and pharmacology of this substance are in progress.

We thank Mr. D. B. Fanshaw, conservator of forests, British Guiana, for the barks; Major J. Buchanan, of Messrs. A. C. Cossor, Ltd., for technical advice with the Cossor 1314, E.C.G., and Mr. G. E. Trease, director of pharmaceutical studies in the University of Nottingham, for permission to publish this communication.

J. N. Banerjee
J. J. Lewis

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Department of Pharmacy,
University, Nottingham. Dec. 4.

[1] Sollmann, T., *J. Pharmacol. Exp. Ther.*, **11**, 1 (1918).
[2] Bulbring, E., and Wajda, I., *J. Pharmacol. Exp. Therap.*, **85**, 78 (1945).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, May 4

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. P. de Béthune: "Appalachian Relief".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Annual General Meeting, with Presidential Address.

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. E. P. Johnson: "Gas Turbines in Retrospect and Prospect".

Tuesday, May 5

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. D. M. MacKinnon: "On the Notion of a Philosophy of History".*

UNIVERSITY OF LONDON (in the Chemistry Lecture Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. R. W. G. Wyckoff, For.Mem.R.S.: "The Structure of some Biologically Important Solids".*

Wednesday, May 6

UNIVERSITY OF LONDON (at the School of Pharmacy, 17 Bloomsbury Square, London, W.C.1), at 5.30 p.m.—Dr. W. O. James, F.R.S.: "The Formation of Alkaloids in Plants".* (Further Lecture on May 7.)

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. G. I. Hitchcox: "Recent Advances in the Application of Electronics to Chemical Instrumentation".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (joint meeting of the MICROCHEMISTRY GROUP and the SCOTTISH SECTION, in the Chemistry Department, The University, Glasgow), at 7.15 p.m.—Scientific Papers.

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Nature and Constitution of Viruses" (Chairman: Dr. A. S. McFarlane; Speakers: Dr. P. R. Lépine, Dr. R. W. G. Wyckoff, For.Mem.R.S., Mr. F. C. Bawden, F.R.S.).

Thursday, May 7

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. N. F. Mott, F.R.S.: "Dislocations, Plastic Flow and Creep in Metals" (Bakerian Lecture).

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. John Gilmour, Dr. J. Ramsbottom, Dr. T. A. Sprague and Mr. W. T. Stearn: Papers to commemorate the Bicentenary of the publication of the "Species Plantarum".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. J. Davies: "Research in the Electrical Manufacturing Industry".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Friday, May 8

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. A. J. S. Pippard: "The Civil Engineer in the Laboratory".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Reading (May 9).

COLVILLE FELLOWSHIP TENABLE IN THE DEPARTMENT OF CHEMISTRY—The Professor of Chemistry, Royal Technical College, George Street, Glasgow (May 9).

ENGINEER to control, under Assistant Director, large engineering workshop making wide range experimental apparatus at the Ministry of Supply, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.193/53A (May 9).

LECTURER (Grade B) IN THE DEPARTMENT OF MATHEMATICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (May 9).

PLANT PHYSIOLOGIST IN THE BOTANY DEPARTMENT—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Street, Edinburgh (May 9).

ASSISTANT BIOCHEMIST (Basic Grade) (with a university degree or equivalent)—The Group Pathologist, Group Pathological Laboratory, Lakin Road, Warwick (May 11).

READER IN CIVIL ENGINEERING at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 11).

SENIOR LECTURER or LECTURER IN CIVIL ENGINEERING, a SENIOR LECTURER or LECTURER IN ELECTRICAL ENGINEERING, two SENIOR LECTURERS or LECTURERS IN MATHEMATICS, two SENIOR LECTURERS or LECTURERS IN CHEMISTRY, a SENIOR LECTURER or LECTURER IN PHYSICS, and a SENIOR LECTURER or LECTURER IN ZOOLOGY, at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Council on Colonial Colleges, 15 Victoria Street, London, S.W.1 (May 11).

ASSISTANT LECTURER IN CHEMISTRY—The Principal, Royal Holloway College, Englefield Green, Surrey (May 15).

LEVERHULME STUDENTSHIPS IN CHEMICAL ENGINEERING—The Registrar, University College, Gower Street, London, W.C.1 (May 15).

SENIOR LECTURER IN VETERINARY MEDICINE—The Secretary of University Court, The University, Glasgow (May 15).

ELECTRICAL ENGINEERS and PHYSICISTS (Scientific Officer grade—Ref. A.92/53A; Experimental Officer or Assistant Experimental Officer grade—Ref. A.337/52A) for interesting research or development work on radar equipment for Forces, in the Ministry of Supply at Malvern—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (May 16).

ESSO RESEARCH STUDENTSHIP IN CHEMISTRY—The Professor of Chemistry, The University, Southampton (May 16).

LECTURER IN ZOOLOGY (with special interest in entomology)—The Secretary, Birkbeck College, Malet Street, London, W.C.1 (May 16).

LECTURERS (2) IN ENGINEERING (with special qualifications in mechanical engineering with particular interest in one or more of the following: fluid mechanics and heat transfer, thermodynamics applied to heat engines, theory of machines, the engineering of chemical processes)—The Registrar, The University, Manchester 13 (May 16).

PHYSICIST in a Ministry of Supply Establishment in S.E. London, to assist in work involving application of electron microscopy to explosives and metallurgical problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.93/53A (May 16).

PROFESSOR or READER IN THEORETICAL PHYSICS, a PROFESSOR or READER IN APPLIED MATHEMATICS, a READER or SENIOR LECTURER IN CIVIL ENGINEERING, and a READER or LECTURER (Grade I) IN METALLURGY—The Registrar, The University, Nottingham (May 16).

RESEARCH ASSISTANT IN BIOCHEMISTRY, to work on enzymes in connexion with genetics of micro-organisms—The Registrar, University College, Leicester (May 16).

SCIENTIFIC OFFICERS (with first- or second-class honours degree or equivalent in engineering, physics or mathematics) in the Ministry of Supply, as resident technical representatives at aircraft contractors' works in England—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.213/53A (May 16).

ASSISTANT LECTURER IN PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 18).

CHAIR OF GEOGRAPHY in the University of Ceylon—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 18).

BIOLOGIST (with a first- or second-class degree) IN THE GENERATION OPERATION BRANCH at Headquarters in London, to study the effects of power station operation upon the life of rivers and other waterways, in general and in relation to specific power stations—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1 (May 19).

HEAD OF THE DEPARTMENT OF METALLURGY, County Technical College, Wednesbury—The Director of Education, Department F.E., County Education Offices, Stafford (May 20).

LECTURER IN PURE MATHEMATICS—The Registrar, King's College, Strand, London, W.C.2 (May 22).

ASSISTANT CHEMIST—The Chief Engineer, Middlesex County Council, Main Drainage Department, Mogden Works, Isleworth, quoting L.951T (May 23).

LECTURER or an ASSISTANT LECTURER IN BIOCHEMISTRY—The Registrar, The University, Leeds 2 (May 25).

CHAIR OF AGRICULTURE in University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 30).

LECTURERS IN STATISTICS AND APPLIED MATHEMATICS at the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 30).

LECTURER or ASSISTANT LECTURER IN MATHEMATICS at University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 30).

SENIOR LECTURER IN PHYSICS, and LECTURERS IN BOTANY, PHYSICAL CHEMISTRY, GEOLOGY, ZOOLOGY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 30).

LECTURER IN ECONOMICS at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

LECTURER IN PSYCHOLOGY (preferably with qualifications and research interests in social psychology), a LECTURER IN GEOGRAPHY (experience in cartography and field techniques an advantage), a LECTURER IN ZOOLOGY (preferably with interest in vertebrate zoology or comparative physiology), a LECTURER IN CIVIL ENGINEERING (preferably with interests in hydraulics and soil mechanics), a LECTURER IN BIOCHEMISTRY (preferably with interests in protein chemistry), and a LECTURER IN PHILOSOPHY, at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, May 31).

LECTURER IN VETERINARY PATHOLOGY—The Registrar and Secretary, The University, Bristol (May 31).

COKE RESEARCH FELLOWSHIP for research in the Department of Fuel Technology, ELLISON RESEARCH FELLOWSHIPS (3) for research in Chemistry or Physics, and C. G. CARLISLE RESEARCH SCHOLARSHIP for research in Metallurgy—The Registrar, The University, Sheffield (June 1).

LECTURER or ASSISTANT LECTURER IN PATHOLOGY—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (June 1).

ASSISTANT LECTURER (with an honours or special degree in geology) IN THE DEPARTMENT OF GEOLOGY—The Secretary, Bedford College, Regent's Park, London, N.W.1 (June 5).

SENIOR LECTURER IN THE DEPARTMENT OF CHEMISTRY at University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 13).

PHYSICISTS to work on nuclear induction and in related fields—The Academic Secretary, Weizmann Institute of Science, Rehovoth, Israel (June 15).

RESEARCH STUDENTSHIPS IN SCIENCE—The Registrar, The University, Manchester 13 (July 1).

BIOCHEMIST (senior grade, non-medical)—The Physician Superintendent, Crichton Royal Mental Hospital, Dumfries.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER at Royal Greenwich Observatory, Herstmonceux, for recording of cosmic ray intensity and development of photoelectric instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.101/53A.

HUGH WOOD MEMORIAL FELLOWSHIP IN MINING—The Registrar, The University, Leeds 2.

RESEARCH FELLOWSHIP IN MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in metallurgy) in a Ministry of Supply Establishment, South-East London, for physical metallurgical research—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.159/53A.

SENIOR LECTURER with qualifications and experience IN CHEMICAL ENGINEERING at Bradford Technical College—The Director of Education, Town Hall, Bradford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 55, Section A, No. 4: Solar Eclipses visible in Ireland between A.D. 400 and A.D. 1000. By F. J. O'Connor. Pp. 61–72. 1*s.* 6*d.* Vol. 55, Section A, No. 5: A New Quaternion Approach to Meson Theory. By C. W. Kilmister. Pp. 73–100. 4*s.* 6*d.* Vol. 55, Section A, No. 6: Note on the Production of Pseudo-scalar Mesons. By Rev. J. McConnell. Pp. 101–108. 1*s.* 6*d.* (Dublin: Hodges, Figgis and Co., Ltd., 1952–1953.) [53

Proceedings of the Royal Irish Academy. Vol. 55, Section B, No. 3: Revision of certain Ordovician Fossils from County Tyrone. By F. Cowper Reed. Pp. 29–136+5 plates. 11*s.* Vol. 55, Section B, No. 4: Antitubercular Substances, 9, Long-chain Aliphatic Bases. By Vincent C. Barry, M. L. Conalty and Dermot Twomey. Pp. 137–148. 2*s.* Vol. 55, Section B, Nos. 5, 6: Antitubercular Substances, 10, Oxidation Products of Derivatives of *o*-Phenylene Diamine, by Vincent C. Barry and J. G. Belton; Antitubercular Substances, 11, Some Further Phenazine Pigments derived by Oxidation of *o*-Phenylene Diamine Derivatives, by Vincent C. Barry, J. G. Belton, J. F. Chambers, M. L. Conalty, Rose Keily and D. Twomey. Pp. 149–164. 2*s.* Vol. 55, Section B, No. 7: The Application of the Barry Degradation to Snail Galactogen. By Proinsias O'Colla. Pp. 165–170. 1*s.* (Dublin: Hodges, Figgis and Co., Ltd., 1952–1953.) [53

Macaulay Institute for Soil Research. Annual Report, 1951–1952. Pp. 52+2 plates. (Aberdeen: Macaulay Institute for Soil Research, 1953.) [53

Carnegie Trust for the Universities of Scotland. Fifty-first Annual Report (for the Year 1951–52) submitted by the Executive Committee to the Trustees on 23rd February 1953. Pp. iv+80. (Edinburgh: Carnegie Trust for the Universities of Scotland, 1953.) [53

Books for Young People. Group 2: Eleven to Thirteen plus, Annotated and Classified. Compiled by the North Midland and Yorkshire Branches of the Library Association under the editorship of Edgar Osborne. Pp. 123. (London: Library Association, 1953). 10*s.*; 7*s.* 6*d.* to members. [53

Contributions of Science to Peace (Alex Wood Memorial Lecture 1953 delivered in Friends House, London, February 18th, 1953.) By Prof. Charles A. Coulson. Pp. 28. (London: Fellowship of Reconciliation, 1953.) 1*s.* 6*d.* [53

John Innes Leaflet No. 12: Soil Blocks. Pp. 8. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 9*d.* [53

University of London: University College. Annual Report, 1951–1952. Pp. 140. (London: University College, 1953.) [53

Department of Scientific and Industrial Research: Radio Research. Special Report No. 25: Selected Problems in the Preparation, Properties and Application of Materials for Radio Purposes. Pp. iv+24. (London: H.M. Stationery Office, 1953.) 1*s.* 6*d.* net. [53

Negretti and Zambra, Ltd. Seventh Annual Report and Accounts for the Year ended 30th September 1952. Pp. 16. (London: Negretti and Zambra, Ltd., 1953.) [53

Other Countries

Conseil International des Unions Scientifiques: Union Géodésique et Géophysique Internationale: Association de Sélsmologie et de Physique de l'Intérieur de la Terre. Comptes rendus des séances de la neuvième Conférence réunie à Bruxelles du 20 Août au 1er Septembre 1951. Rédigés par J. P. Rothé. Pp. xii+288. (Strasbourg: Association de Sélsmologie et de Physique de l'Intérieur de la Terre, 1952.) [43

Forest Research in India, 1947–48. Part 2: Reports for Burma and Indian Provinces. Pp. iii+75. (Delhi: Manager of Publications, 1952.) 5.4 rupees; 8*s.* 3*d.* [43

Indian Forest Records (New Series). Chemistry and Minor Forest Products, Vol. 1, No. 2: The Vegetable Tanning Materials of India and Burma. By M. V. Edwards, R. L. Badhwar and A. C. Dey. Pp. x+191. (Delhi: Manager of Publications, 1952.) 6 rupees; 9*s.* 6*d.* [43

Bulletin of the Museum of Comparative Zoology. Vol. 107, No. 8: Airplace Observations of Homing Pigeons. By Donald R. Griffin. Pp. 409–440. (Cambridge, Mass.: Harvard College, 1952.) [43

National Research Council: Division of Geology and Geography. Publication 245: Report of the Committee on the Measurement of Geologic Time, 1951–1952. Pp. iii+151. (Washington, D.C.: National Academy of Sciences, 1953.) 1.50 dollars. [43

Fieldiana. Zoology, Vol. 33, No. 2: Mammals. By Colin Campbell Sanborn. (Philippine Zoological Expedition, 1946–1947.) Pp. 87–158. 1.50 dollars. Zoology, Vol. 34, No. 8: On the Mollusk Fauna of the Landlocked Waters of Bermuda. By Fritz Haas. Pp. 101–106. 10 cents. Zoology, Vol. 34, No. 9: South American Non-Marine Shells; Further Remarks and Descriptions. By Fritz Haas. Pp. 107–132. 60 cents. (Chicago: Chicago Natural History Museum, 1952.) [43

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